APPENDIX E

Mississippi River Borrow Area Design Analysis

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MISSISSIPPI RIVER BORROW AREA DESIGN ANALYSIS

1.0 INTRODUCTION

The Mississippi River Borrow Area Design Analysis were completed in support of the Preliminary Design Phase for the Riverine Sand Mining / Scofield Island Restoration Project (Project). The Project is sponsored by the Louisiana Department of Natural Resources (LDNR), State of Louisiana Office of Coastal Protection and Restoration (OCPR) and NOAA Fisheries. The Project design is funded and authorized in accordance with the provisions of the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) (16 U.S.C.A., Sections 3951-3956) and has been approved by the Public Law 101-646 Task Force. The Project's CWPPRA designation is BA-40.

The scope of services included detailed review of prior surveys and analyses, evaluation of geophysical and geotechnical survey data, compatibility analysis of Riverine sediments to Scofield Island native beach sediments, borrow area geometry refinement, and volume estimates. The design analysis was conducted by Coastal Engineering Consultants, Inc (CEC) and reviewed by SJB Group, LLC. (SJB), and Coastal Technology Corporation, Inc. (CTC).

1.1 Geological Framework of the Lower Mississippi River

Studies relevant to sand sources in the Lower Mississippi River (LMR), including several noteworthy reports, are numerous and were previously reviewed and summarized by the Finkl et al. (2005) geotechnical investigation. The reports reviewed describe the LMR as naturally entrenched in the alluvial plain as it approaches the modern "bird's foot" delta. Average sediment grain size characteristics tend to decrease as the river approaches the gulf. As the river moves southward, mixed sediment associated with deltaic progradation becomes more predominant and overlies a sandy Pleistocene layer similar to sediments found on the inner continental shelf. Below New Orleans lateral migration of the river channel was historically less than observed in upstream reaches as it encountered less friction associated with more rugged terrain. This phenomenon has been intensified by engineered projects for navigation and flood control. Although to a lesser degree than upriver, historic channel migration would result in relict point bar sand deposits. Modern river modifications and channelization have resulted in Riverine sand deposition responses in the form of "mid-channel bars" or "sand waves." Many of these active deposits are found between Empire and Venice and are fed by bed load sands. In recent years these active sand deposits have been studied and targeted as potential renewable resources for restoration.

1.2 Summary of Prior Work

The selection of the Project Riverine borrow areas was based on the review of prior surveys and analyses that identified multiple areas within the river as containing significant quantities of beach compatible sand. The primary sources of this information included previous geophysical and geotechnical work performed by Coastal Planning and Engineering (CPE, 2004) and Finkl et al. (2005), transport methodology and conveyance corridor analysis (SJB and CEC, 2007a), Mississippi River mining impact assessment (SJB and CHF, 2007), Mississippi River borrow area mining technical analyses (SJB and CEC, 2007b; SJB and CEC, 2007c), previous cultural resources work performed by R. Christopher Goodwin & Associates, Inc. (CGA, 2008), and the Feasibility Study Phase analyses (SJB and CEC, 2008).

CPE (2004) and Finkl et al. (2005) identified potential sand sources within the lower Mississippi River including the two areas designated as MR-B and MR-E. Based on the subsequent surveys and analyses, the boundaries of the two areas were revised multiple times. For the Preliminary Design Phase, these borrow areas have been designated as MR-B-09 and MR-E-09 to reflect that while the approximate locations remained the same, the design limits were refined.

The surveys and analyses completed in support of the Preliminary Design Phase for the borrow areas included the Mississippi River Borrow Area Geophysical Survey (Appendix A), Mississippi River Borrow Area Geotechnical Survey (Appendix B), Mississippi River Borrow Area Sediment Analyses (Appendix C), and Mississippi River One-Dimensional Modeling Analysis (Appendix D).. Details of the full geophysical and geotechnical surveys are described in Alpine Ocean Seismic Survey, Inc. (AOS, 2009a and 2009b). Native sediment and Riverine vibracore sample testing results are presented in CTC (2008) and CTC (2009), respectively.

The preliminary assessment of cultural resources for Borrow Areas MR-B-09 and MR-E-09 was conducted as part of the Feasibility Study Phase and followed report guidelines established by the Louisiana Department of Recreation, Culture, and Tourism, Division of Archaeology (LDRCT). A full explanation and detailed review of the findings can be found in the Mississippi River Borrow Area – Hazard, Environmental, and Archaeological Assessment (SJB and ARI, 2007).

A historical compilation of available geology and soil data for the west bank of the Mississippi River from the vicinity of Jesuit Bend to Venice, a distance of about 56 river miles, was also reviewed. The report entitled Mississippi River Levees and Banks, River Mile 66 to River Mile 10, Soil Report – Part I, by the US Army Corps of Engineers (USACE, 1971) included soil boring logs, results of laboratory tests, and soil profiles, several of which were within the boundaries of MR-E-09.

1.3 Project Area and Location

Borrow Area MR-B-09 is located on the east side of the Mississippi River near Empire, Plaquemines Parish, between approximate River Mile Marker (MM) 29 to 31, and Borrow Area MR-E-09 is located on the west side of the river south of Buras between approximate MM 23 to 24 as presented in Figure 1.

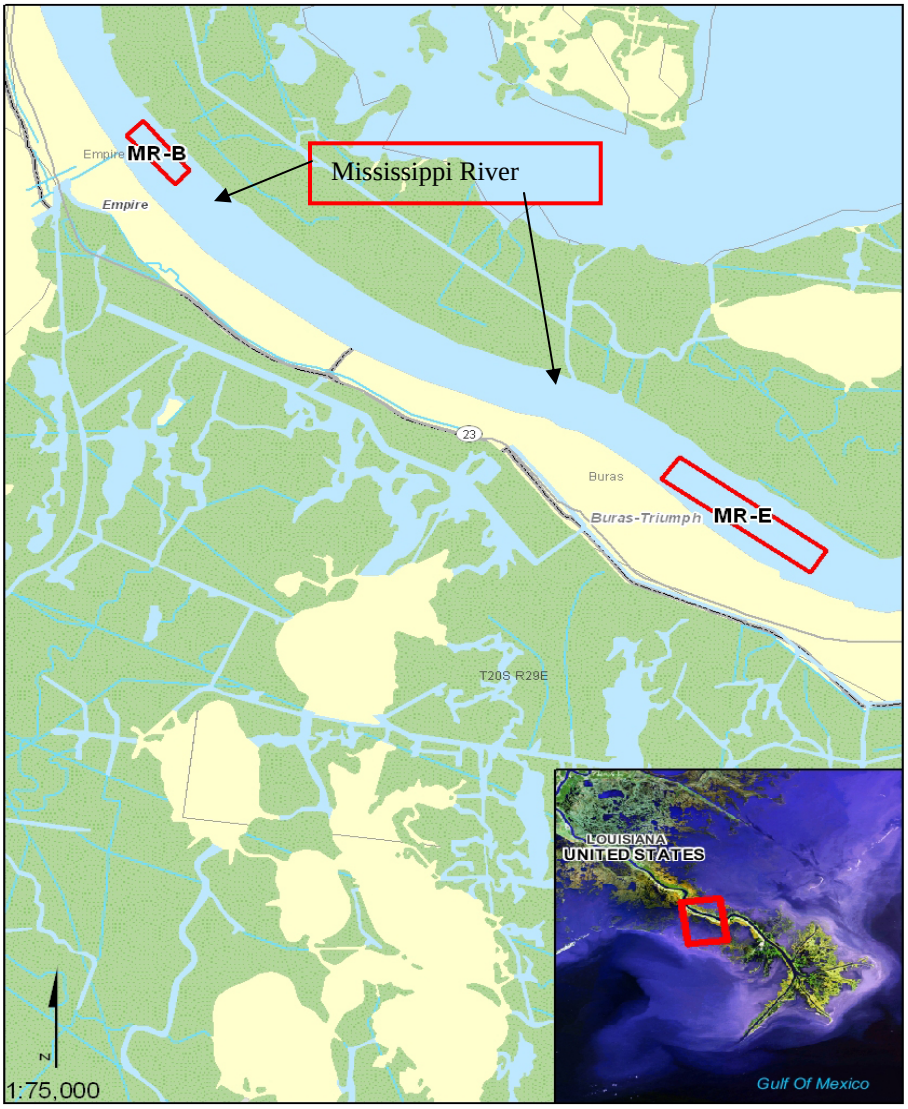


Figure 1-1: Mississippi River Borrow Area Location Map

1.4 Bedform Definitions

The following terms are used to describe the bedforms observed in the sidescan and subbottom survey data. The values for bedform wave height and length are general characterizations and may vary.

- Megaripples: Mounds or ridges of sand which are asymmetrical and produced subaqueously by flowing water. The external morphology is similar to the larger sand wave, with a gently sloping, upstream side and a steeper downstream side. The crestline elongation extends transverse to the flow direction and is sinuous or lunate in plan. The wave height varies between 0.3 feet and 4 feet, while the wave length (spacing) between crests ranges from 3 feet to 40 feet. The down-current migration of the bedforms leads to the formation of cross-bedding in sediments which is the source of steeply dipping reflectors in the seismic records.
- Sand waves: Large-scale, transverse ridge of sand, with external morphology similar to that of the smaller-scale megaripple. The wave height is typically greater than 4 feet, while the wave length may range from 100 feet to over 1500 feet.

2.0 MR-B-09 BORROW AREA ANALYSIS

2.1 MR-B-09 Geophysical Survey

A preliminary review of the data collected in an area encompassing Borrow Area MR-B-09 (CGA, 2008) indicated that the magnitude and level of detail of the survey would be sufficient to fulfill the cultural resources survey requirements of Borrow Area MR-B-09 for the Preliminary Design Report. The data collected by CGA included bathymetry, magnetometer, sidescan sonar, and subbottom profiling at a line spacing much tighter than required for preliminary design geophysical surveys.

Figure 2-1 shows the track lines run within Borrow Area MR-B-09 during the CGA survey (CGA, 2008). The seismic lines were examined using electronic software provided by CGA and typical screen snapshots from that effort are plotted in Figure 2-1. Major sand wave and sandy sedimentary strata are discernable (CGA, 2008) and drawn as an overlay on the seismic data (Figure 2-1). Excerpted snapshots from several profiles through the channel are included as examples. The data primarily depict sand waves with superimposed megaripples throughout the This work provided a confirmation of extensive bottom coverage by sand wave bedform features over most of the area examined and confirmed the presence of unconsolidated sand near the surface in the borrow area.

To compliment this data, AOS (2009a) conducted selective geophysical surveys consisting of magnetometer surveys, sidescan sonar, bathymetric, and seismic subbottom surveys in specific areas of MR-B-09, The track lines are shown in Figure 2-2.. The purpose of the magnetometer survey was to verify existing facilities, pipelines, and other obstructions that may affect usage of the recommended borrow area.

These data were used for calibration and refinement of the prior study conducted by CGA in Borrow Area MR-B-09. AOS (2009a) conducted a geophysical survey transect along a previously surveyed track conducted by CGA (2008), in addition to several cross channel bathymetry transects. Prior analysis by SJB and CEC (2007c, 2008) identified two potential pipelines and/or pipeline and utility cable within the delineation of Borrow Area MR-B-09. AOS (2009a) conducted several close spaced magnetometer survey passes in the vicinity of the identified utility crossings for clarification of their existence and locations. The magnetometer survey lines were field adjusted as real-time review during data collection. The magnetometer survey plans by CGA (2008) and AOS (2009a) are shown in Figures 2-3 and 2-4, respectively.

2.1.1 MR-B-09 Magnetometer and Sidescan Sonar Results

Sidescan sonar data were acquired over the entire MR-B-09 area by CGA (2008) as shown in Figure 2-3 and in the southern portion of MR-B-09 by AOS (2009a) as shown in Figure 2-4. The sidescan was used in conjunction with magnetometer data to identify any hazards to sand mining operations on the riverbed and to determine whether there were any exposed portions of two reportedly removed pipelines near the head of the Empire Waterway.

During the remote sensing survey by CGA (2008) numerous magnetic and acoustic anomalies were recorded. The application of pattern recognition protocols and examination of remote sensing data permitted the discrimination of anomaly clusters meriting more detailed scrutiny. Similarly, insignificant point source and acoustic anomalies, not representative of cultural resources, were eliminated from further consideration. As a result, 27 targets were identified for further analysis. Only Targets #13, #30, #31, and #32 exhibit characteristics that suggest that they may represent significant submerged cultural resources. All of these are located outside the perimeter of MR-B-09. Four Targets, #9, #11, #14, and #15, were near the edge of the borrow area, which were avoided by placing a perimeter buffer around each target as depicted in Figure 2-3. Numerous additional MR-B-09 magnetic anomalies were identified by AOS (2009a) within the survey area (Figure 2-4), suggesting abundant scattered debris in this area. Although only one anomaly (#91) clearly correlated with a sonar target (#11), both are outside the borrow area (Figure 2-4) and in deep water. It is likely most of these anomalies are related to debris (CGA, 2008) and AOS, 2009a). No clear linear correlation suggesting the presence of a pipeline was found among the anomalies. Scattered debris may naturally collect in this area.

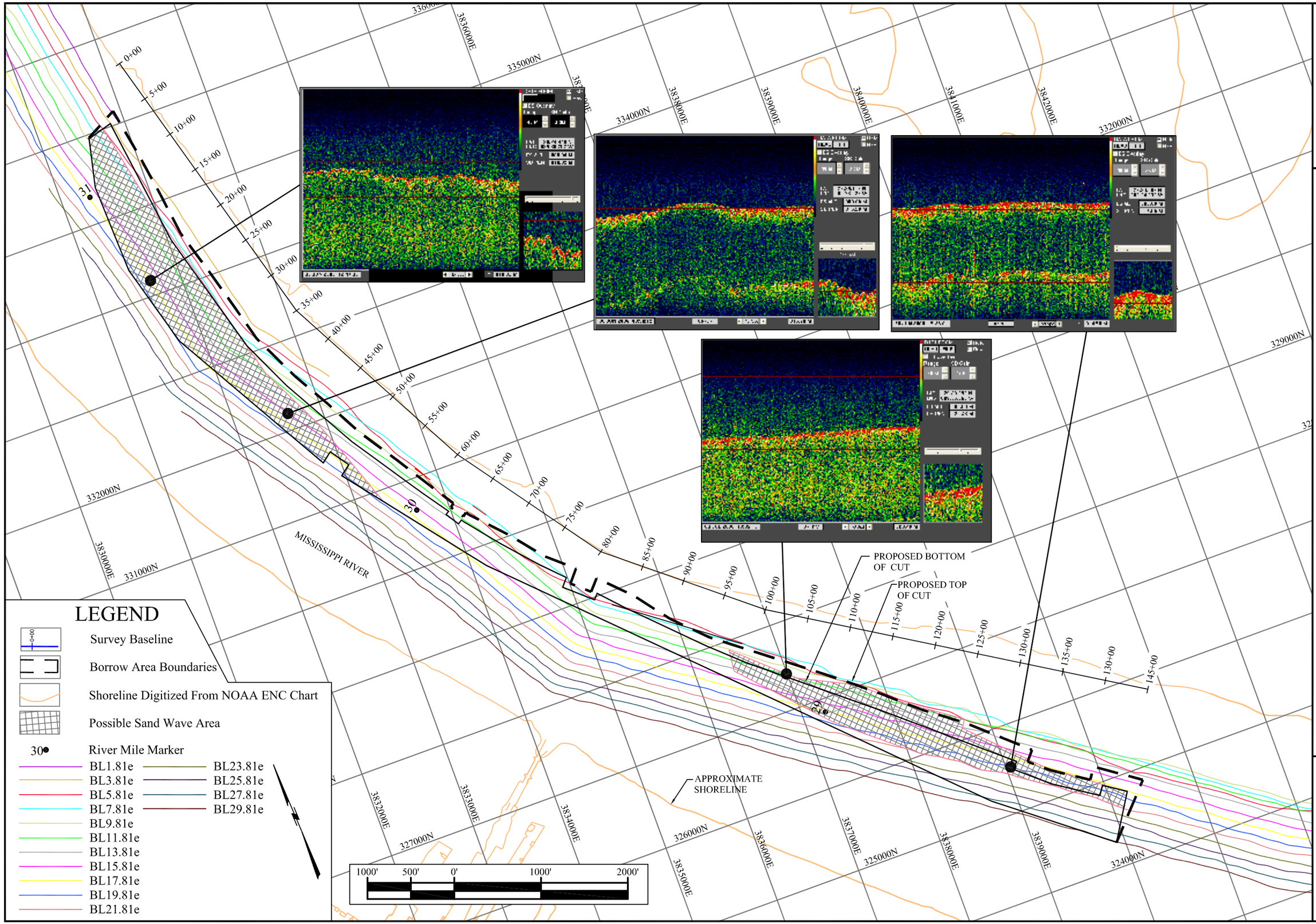


FIGURE 2-1: MR-B-09: CGA SEISMIC TRACK LINES AND TYPICAL SEISMIC PROFILES

COASTAL ENGINEERING CONSULTANTS INC.
PH: (239) 643-2324
FAX: (239) 643-1143
3106 SOUTH HORSESHOE DRIVE
NAPLES, FLORIDA 34104

STB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751
BATON ROUGE, LA. 70821
PHONE (225) 769-3400
FAX (225) 769-3596

LEGEND

- Survey Baseline
- Borrow Area Boundaries
- Shoreline Digitized From NOAA ENC Chart
- Vibracore: MRVC-05-XX (2005)
- Vibracore: MRB-08-XX (2008)
- Seismic Track Line
- Revetment
- River Mile Marker

GEODETIC INFORMATION
Horizontal DATUM : WGS84
PROJECTION: NAD 83 Louisiana South State
Plane Vertical FEET DATUM: FEET NAVD 88

MRB-08-01
MRB-08-07
MRB-08-02
MRVC-05-04
MRB-08-04
MRVC-05-05
MRB-08-05
MRB-08-06
MRVC-05-06
SEE FIGURE 2-5 FOR TYPICAL SEISMIC PROFILE
SEE FIGURE 2-5 FOR TYPICAL SEISMIC PROFILE
BOTTOM OF CUT
TOP OF CUT
MR LEVEE
EMPIRE LOCKS
31
30
29
E
E'
D
D'

1000' 500' 0' 1000' 2000'

COASTAL ENGINEERING CONSULTANTS INC.
PH: (239) 643-2324
FAX: (239) 643-1143
3106 SOUTH HORSESHOE DRIVE
NAPLES, FLORIDA 34104

FIGURE 2-2: MR-B-09: AOS SEISMIC TRACK LINES AND VIBRACORE LOCATIONS

STB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751
BATON ROUGE, LA. 70821
PHONE (225) 769-3400
FAX (225) 769-3596

LEGEND

- Survey Baseline
- Borrow Area Boundaries
- Shoreline Digitized From NOAA ENC Chart
- AlpineMagnetic Anomaly Number & Location
- Alpine Sidescan Target Number & Location
- Goodwin Acoustical Targets
- Goodwin Magnetic Targets
- Revetment
- River Mile Marker

GEODETIC INFORMATION
Horizontal DATUM : WGS84
PROJECTION: NAD 83 Louisiana South State Plane Vertical DATUM: FEET NAVD 88

TARGET 8 DEBRIS
TARGET 9 DEBRIS
TARGET 10 BANK FAILURE
TARGET 11 DEBRIS
TARGET 12 DEBRIS
TARGET 13 POSSIBLE SHIPWRECK
TARGET 14 BOTTOM DISTURBANCE
TARGET 15 DEBRIS
BOTTOM OF CUT
TOP OF CUT
MR LEVEE
EMPIRE LOCKS
MR
31
30
29

1000' 500' 0' 1000' 2000'

FIGURE 2-3: MR-B-09: SIDESCAN AND MAGNETOMETER TARGETS

COASTAL ENGINEERING CONSULTANTS INC.
PH: (239) 643-2324
FAX: (239) 643-1143
3106 SOUTH HORSESHOE DRIVE
NAPLES, FLORIDA 34104

STB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751
BATON ROUGE, LA. 70821
PHONE (225) 769-3400
FAX (225) 769-3596

400' 200' 0' 400' 800'

LEGEND

- Survey Baseline
- Borrow Area Boundaries
- Shoreline Digitized From NOAA ENC Chart
- Alpine Magnetic Anomaly Number & Location
- Alpine Sidescan Target Number & Location
- Linear Sidescan Targets
- Goodwin Acoustical Targets
- Goodwin Magnetic Targets
- Vibracore: MRB-08-XX (2008)
- Revetment
- River Mile Marker

GEODETIC INFORMATION
Horizontal DATUM : WGS84
PROJECTION: NAD 83 Louisiana South State
Plane Vertical DATUM: FEET NAVD 88

TOP OF CUT
BOTTOM OF CUT
MRB-08-06
MRB-08-05
MRB-08-04
MRB-05-06
MRB-05-05
70+00
75+00
80+00
85+00
90+00
95+00
100+00
105+00
110+00
115+00
120+00
125+00
29

FIGURE 2-4: MR-B-09: AOS SEAFLOOR FEATURES, SIDESCAN, AND MAGNETOMETER TARGETS

COASTAL ENGINEERING CONSULTANTS INC.
PH: (239) 643-2324
FAX: (239) 643-1143
3106 SOUTH HORSESHOE DRIVE
NAPLES, FLORIDA 34104

STB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751 BATON ROUGE, LA. 70821
PHONE (225) 769-3400
FAX (225) 769-3396

In the southern portion of MR-B-09 it was confirmed that no exposed pipelines or segments of pipe were found within the survey area (AOS, 2009a). Twenty-eight sidescan targets were found within the survey area (Figure 2-4). Of these, the largest target (#72) is 36 feet x 25 feet x 0.5 feet. This object is within 100 feet of magnetic anomalies #73 and #74, but it is unclear whether or not they are related. It is possible this target is naturally made and not debris related. All are outside the proposed borrow area. A cluster of scattered debris (#s 58-62) and target #3 was found at or near magnetic anomaly #10. This area was avoided by placing a buffer around the targets. As shown on the sidescan record, sand waves with superimposed megaripples were found throughout the survey area. No other significant features or hazards were found within MR-B-09 (AOS, 2009a).

2.1.2 MR-B-09 Subbottom Profiler Results

The selected subbottom profile cross-lines and long lines run by AOS in MR-B-09 are presented in Figure 2-2, and a typical detail seismic section is shown in Figure 2-5, AOS (2009a). The most prominent features observed in the seismic track lines are sand waves. Previous cores sampled in this area (Finkl et al., 2005) documented good, clean, coarse-grained sand (0.17 mm average) in these bottom features. The seismic data collected shows series of relatively steeply dipping reflectors. Such features are generally indicative of sediment deposition in a more active current regime, while flat-lying layers are often indicative of sediments deposited in a quiet environment.

2.2 MR-B-09 Geotechnical Survey

Additional vibracores (AOS, 2009b) and geotechnical testing (CTC, 2009) were conducted to complement the prior historical geotechnical surveys (Finkl et al., 2005). A plan view map of core locations is shown in Figure 2-6. Six vibracores were collected along the northeastern bank of the River in 35 feet to 45 feet of water to define the sediment characteristics of 3 to 4 million cubic yards of potential borrow area sediment along this bank of the Mississippi River in MR-B-09. The geotechnical survey by AOS (2009b) was conducted in accordance with the USACE "Standards for Subsurface Investigations" and in accordance with the OCPR "General Guidelines: Exploration for Offshore Sand Deposits."

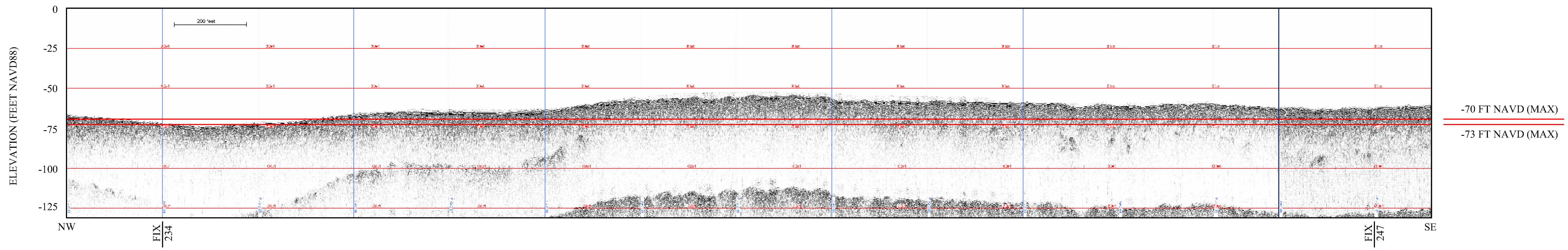
The vibracore was configured to collect 30 foot cores at all sites in MR-B-09. The core sites were selected in an attempt to provide a close overlay of the geophysical survey data collected by AOS (2009a). Given the magnitude of sand potentially available in 40 feet of water along the eastern bank edge of the borrow area, the 30 foot cores were taken in an attempt to achieve -70 feet NAVD88. Significant valuable data were obtained regarding the sediment characteristics over a large surface area and at depth.

LEGEND:

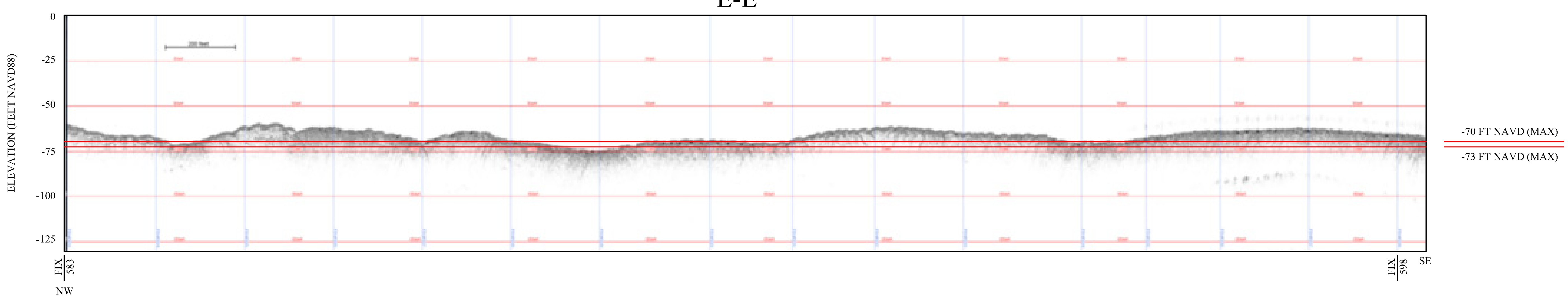
DESIGN

SCALE:
H: 1" = 200'
V: 1" = 25'

D-D'



E-E'



COASTAL ENGINEERING CONSULTANTS INC.
PH: (239) 643-2324
FAX: (239) 643-1143
3106 SOUTH HORSESHOE DRIVE
NAPLES, FLORIDA 34104

FIGURE 2-5: MR-B-09:TYPICAL SEISMIC PROFILE (AOS, 2009)

SJB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751
BATON ROUGE, LA. 70821
PHONE (225) 769-3400
FAX (225) 769-3596

LEGEND

- Survey Baseline (0+00)
- Borrow Area Boundaries
- Shoreline Digitized From NOAA ENC Chart
- Vibracore: MRVC-05-XX (2005)
- Vibracore: MRB-08-XX (2008)
- Bathymetric Contour, 2008 (-20)
- Revetment
- 30 ● River Mile Marker

GEODETIC INFORMATION
Horizontal DATUM : WGS84
PROJECTION: NAD 83 Louisiana South
State Plane Vertical DATUM: NAVD 88

MRB-08-01
MRB-08-07
MRB-08-02
MRVC-05-04
MRB-08-04
MRVC-05-05
MRB-08-05
MRB-08-06
MRVC-05-06
BOTTOM OF CUT
TOP OF CUT
MR LEVEE
EMPIRE LOCKS
31
30
29

0+00 5+00 10+00 15+00 20+00 25+00 30+00 35+00 40+00 45+00 50+00 55+00 60+00 65+00 70+00 75+00 80+00 85+00 90+00 95+00 100+00 105+00 110+00 115+00 120+00 125+00 130+00 135+00 140+00 145+00

331000N 3839000E 332000N 3840000E 330000N 3841000E 329000N 3842000E 328000N
331000N 3829000E 330000N 3830000E 329000N 3831000E 328000N 3832000E 327000N 3833000E 326000N 3834000E

1000' 500' 0' 1000' 2000'

COASTAL ENGINEERING CONSULTANTS INC.
PH: (239) 643-2324
FAX: (239) 643-1143
3106 SOUTH HORSESHOE DRIVE
NAPLES, FLORIDA 34104

FIGURE 2-6: MR-B-09: BATHYMETRIC MAP WITH VIBRACORE LOCATIONS

STB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751
BATON ROUGE, LA. 70821
PHONE (225) 769-3400
FAX (225) 769-3596

The recovered cores were cut into 3-foot sections and capped for ease of handling and labeled to reflect the core name, the sequence within the core, and section orientation. The cores were shipped to CTC for processing.

Figure 2-7 presents a typical core log for MR-B-09, Vibracore MRVC-05-05, that is similar to cores MRVC-05-04 and MRVC-05-06 (Finkl et al., 2005), which were mostly siliciclastic sand with less than 2% fines. This core from deeper water, approximately -50 feet NAVD88, along the central borrow area axis is typical of the sediments in the channel where active bedforms, sand waves and megaripples migrate. The beds show up as clear dipping beds down to 20 or 30 feet in the seismic records.

Several of the northernmost cores in area MR-B-09 appeared both in the field and core logs to contain significant layers or lenses of what appeared to be wood chips or peat. The core, MRB-08-02 (CTC, 2009), represents interdistributary silts and clays, marshy wood chips, and peat interbedded with sand.

Figure 2-8, Vibracore MRB-08-06, obtained in shallower water, approximately -40 feet NAVD88, closer to the riverbank, contained interbedded layers of sand with thin mud or clay layers and a muddy layer at the surface.

As summarized by AOS (2009a), the MR-B-09 survey area is characterized by sand bounded by prodelta and interdistributary silt and clays. The main body of sand thins to the northwest and southeast of the borrow area, as well as on the northeast flank of the borrow area near the riverbank (core MRB-08-02). The sand body extends beyond the southeastern limits of the borrow area. The thickest observed sand sequence is on the southwestern edge of the borrow area. The main sand body is covered in sand waves with superimposed megaripples. The sediments are cross-bedded due to active bedform migration in the down-current direction.

2.3 MR-B-09 Borrow Area Sediment Analyses

Vibracore sampling conducted within the outline of the initial preliminary borrow areas confirmed both the presence of sand within the sediments but also older swamp or quiet water silt-and-clay-rich sediment environments along the eastern edge of the river. The complete core boring logs and gradation analysis of vibracore sediment samples are presented in CTC (2008) and CTC (2009).

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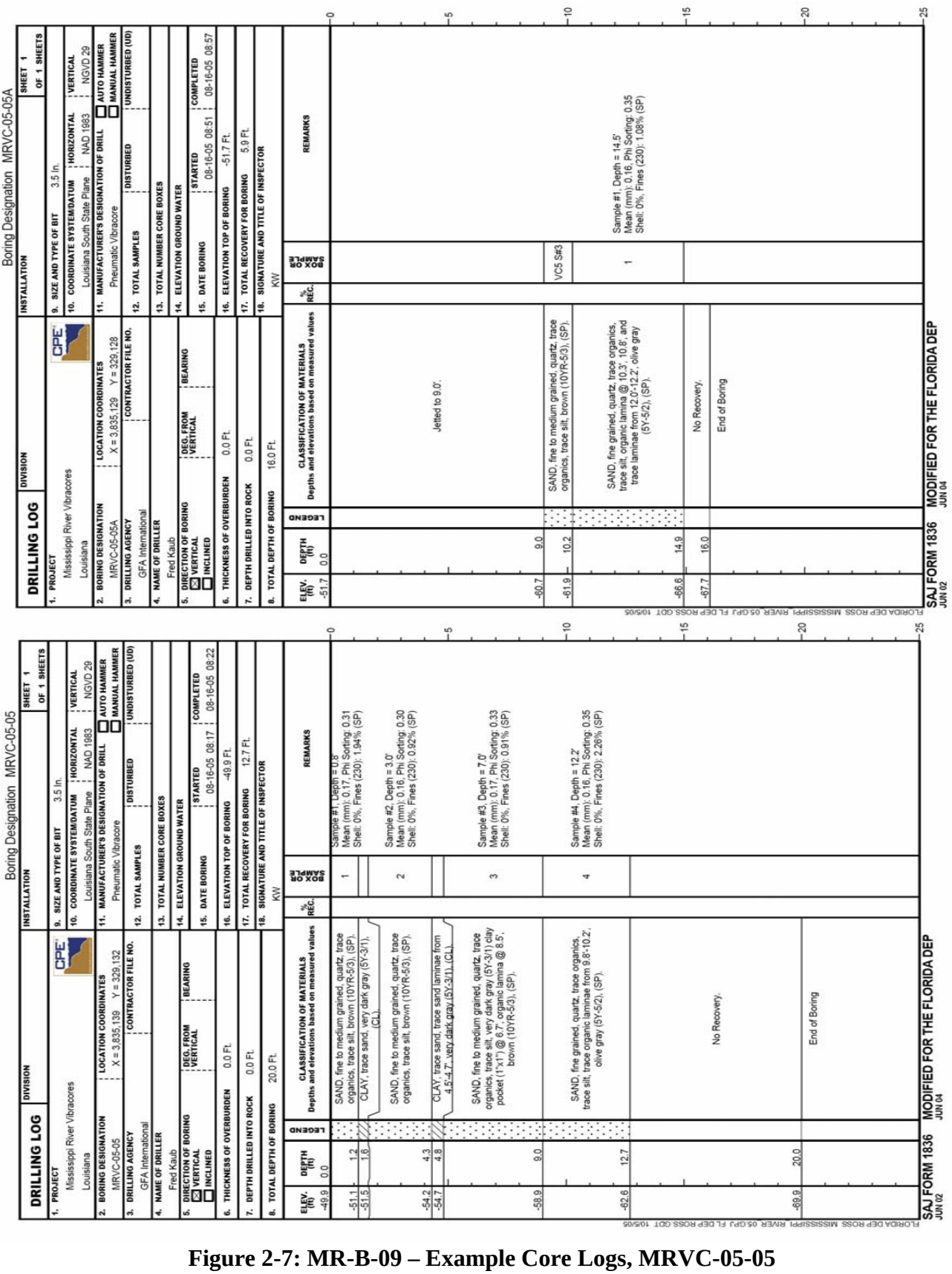
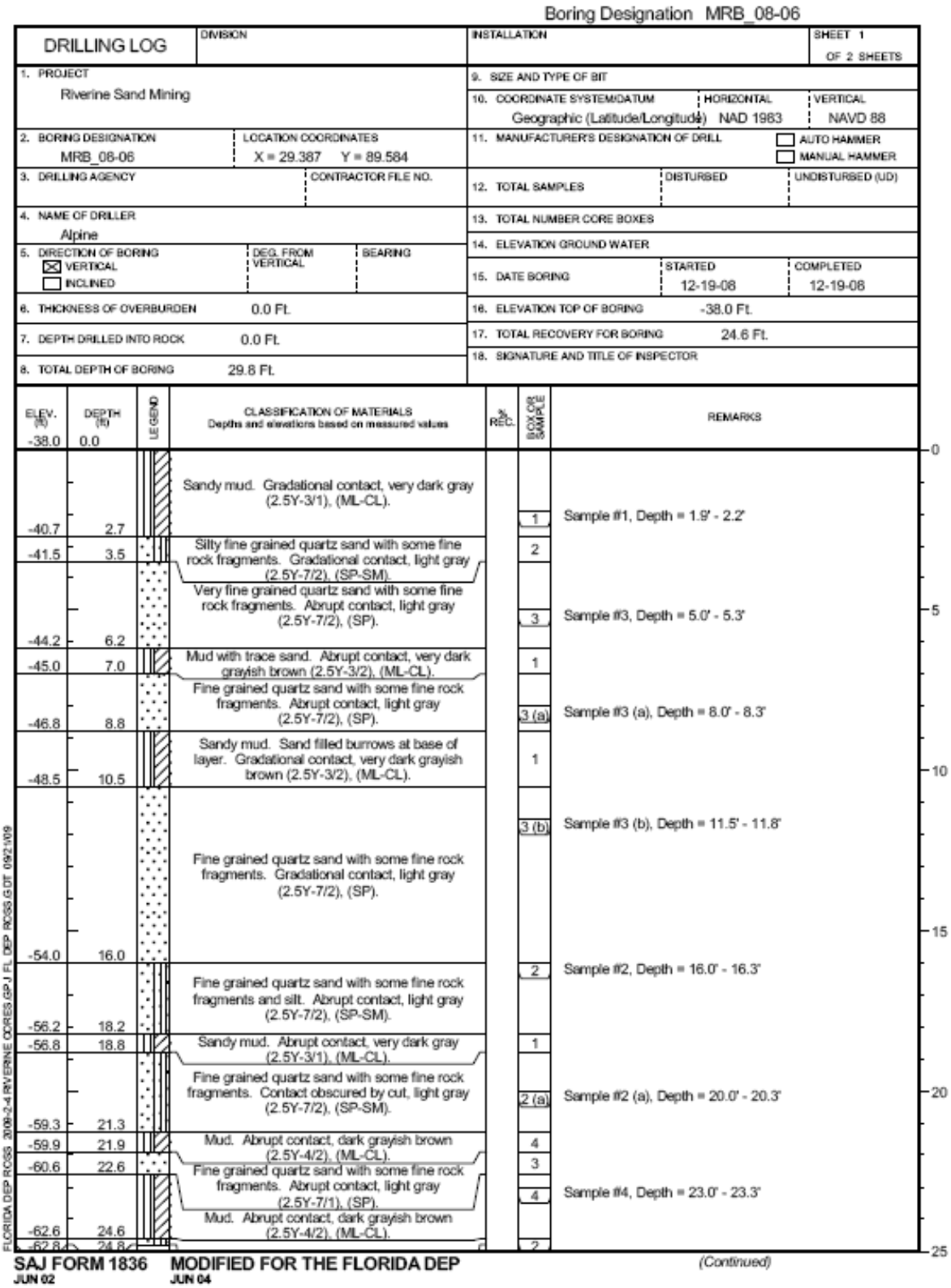


Figure 2-7: MR-B-09 – Example Core Logs, MRVC-05-05



Boring Designation MRB_08-06

DRILLING LOG | DIVISION | INSTALLATION | SHEET 1 OF 2 SHEETS

1. PROJECT: Riverine Sand Mining
2. BORING DESIGNATION: MRB_08-06
LOCATION COORDINATES: X = 29.387 Y = 89.584
3. DRILLING AGENCY
CONTRACTOR FILE NO.
4. NAME OF DRILLER: Alpine
5. DIRECTION OF BORING: ☒ VERTICAL ☐ INCLINED
DEG. FROM VERTICAL
BEARING
6. THICKNESS OF OVERBURDEN: 0.0 Ft.
7. DEPTH DRILLED INTO ROCK: 0.0 Ft.
8. TOTAL DEPTH OF BORING: 29.8 Ft.
9. SIZE AND TYPE OF BIT
10. COORDINATE SYSTEM/DATUM: Geographic (Latitude/Longitude) HORIZONTAL: NAD 1983 VERTICAL: NAVD 88
11. MANUFACTURER'S DESIGNATION OF DRILL ☐ AUTO HAMMER ☐ MANUAL HAMMER
12. TOTAL SAMPLES DISTURBED UNDISTURBED (UD)
13. TOTAL NUMBER CORE BOXES
14. ELEVATION GROUND WATER
15. DATE BORING STARTED: 12-19-08 COMPLETED: 12-19-08
16. ELEVATION TOP OF BORING: -38.0 Ft.
17. TOTAL RECOVERY FOR BORING: 24.6 Ft.
18. SIGNATURE AND TITLE OF INSPECTOR

ELEV. (ft)	DEPTH (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE #	REMARKS
-38.0	0.0					
			Sandy mud. Gradational contact, very dark gray (2.5Y-3/1), (ML-CL).		1	Sample #1, Depth = 1.9' - 2.2'
-40.7	2.7					
-41.5	3.5		Silty fine grained quartz sand with some fine rock fragments. Gradational contact, light gray (2.5Y-7/2), (SP-SM).		2	
			Very fine grained quartz sand with some fine rock fragments. Abrupt contact, light gray (2.5Y-7/2), (SP).		3	Sample #3, Depth = 5.0' - 5.3'
-44.2	6.2					
-45.0	7.0		Mud with trace sand. Abrupt contact, very dark grayish brown (2.5Y-3/2), (ML-CL).		1	
			Fine grained quartz sand with some fine rock fragments. Abrupt contact, light gray (2.5Y-7/2), (SP).		3 (a)	Sample #3 (a), Depth = 8.0' - 8.3'
-46.8	8.8					
-48.5	10.5		Sandy mud. Sand filled burrows at base of layer. Gradational contact, very dark grayish brown (2.5Y-3/2), (ML-CL).		1	
					3 (b)	Sample #3 (b), Depth = 11.5' - 11.8'
			Fine grained quartz sand with some fine rock fragments. Gradational contact, light gray (2.5Y-7/2), (SP).			
-54.0	16.0					
			Fine grained quartz sand with some fine rock fragments and silt. Abrupt contact, light gray (2.5Y-7/2), (SP-SM).		2	Sample #2, Depth = 16.0' - 16.3'
-56.2	18.2					
-56.8	18.8		Sandy mud. Abrupt contact, very dark gray (2.5Y-3/1), (ML-CL).		1	
			Fine grained quartz sand with some fine rock fragments. Contact obscured by cut, light gray (2.5Y-7/2), (SP-SM).		2 (a)	Sample #2 (a), Depth = 20.0' - 20.3'
-59.3	21.3					
-59.9	21.9		Mud. Abrupt contact, dark grayish brown (2.5Y-4/2), (ML-CL).		4	
-60.6	22.6		Fine grained quartz sand with some fine rock fragments. Abrupt contact, light gray (2.5Y-7/1), (SP).		3	
					4	Sample #4, Depth = 23.0' - 23.3'
-62.6	24.6		Mud. Abrupt contact, dark grayish brown (2.5Y-4/2), (ML-CL).			
-62.8	24.8				2	

FLORIDA DEP RCGS 2009-2-4 RIVERINE CORES.GPJ FL DEP RCGS.GDT 9/21/09

SAJ FORM 1836 JUN 02 MODIFIED FOR THE FLORIDA DEP JUN 04

(Continued)

Figure 2-8: MR-B-09 – Example Core Log, MRB-08-06

Cores within the proposed borrow area limits were sampled and tested to determine mean grain size in millimeters (mm) and weighted percentages of coarse grained sediments. An example of the noncohesive sediment grain size from two cores is presented in Table 2-1.

Table 2-1: Composite Grain Size Summary

Borrow Area MR-B-09		
Core	**Weighted Mean GS (mm)**	**Weighted % Coarse (230) ***
MRB-08-05	0.13	96.24
MRB-08-06	0.14	97.35
Average	**0.135**	**96.80**

* = Wentworth Size Class, minimum sand grain size 0.0625 mm, #230 sieve size

A summary of the composite analysis of coarse material from Finkl, et al (2005) is presented for Borrow Area MR-B-09 in Table 2-2 (SJB and CEC, 2007a, b).

Table 2-2: Composite Grain Size Summary

Borrow Area MR-B-09		
Core	**Weighted Mean GS (mm)**	**Weighted % Coarse (230) ***
MRVC-05-04	0.21	99.45
MRVC-05-05/05A	0.16	92.66
MRVC-05-06/06A	0.14	86.02
Average	**0.17**	**92.71**

Source: CPE 2005

* = Wentworth Size Class, minimum sand grain size 0.0625 mm, #230 sieve size

Based on the grain size analysis, the sediments are compatible with the native beach sediments and are suitable for use in the restoring the beach and dune system on Scofield Island.

3.0 MR-B-09 BORROW AREA PLANS AND VOLUME ESTIMATES

By examining the geophysical data in concert with core logs, penetrometer data and individual grain size analyses, the borrow area shape, length, width, and depth were refined to develop the preliminary design plan. A plan view of the borrow area is shown in Figure 3-1.

LEGEND

- Survey Baseline
- Borrow Area Boundaries
- Shoreline Digitized From NOAA ENC Chart
- Vibracore: MRVC-05-XX (2005)
- Vibracore: MRB-08-XX (2008)
- Bathymetric Contour, 2008
- Revetment
- 30 River Mile Marker

GEODETIC INFORMATION
Horizontal DATUM : WGS84
PROJECTION: NAD 83 Louisiana South State Plane Vertical DATUM: FEET NAVD 88

MRB-08-01
MRB-08-07
MRB-08-02
MRB-08-04
MRB-08-05
MRB-08-06
MRVC-05-04
MRVC-05-05
MRVC-05-06
A
A'
B
B'
C
C'
31
30
29
0+00
5+00
10+00
15+00
20+00
25+00
30+00
35+00
40+00
45+00
50+00
55+00
60+00
65+00
70+00
75+00
80+00
85+00
90+00
95+00
100+00
105+00
110+00
115+00
120+00
125+00
130+00
135+00
140+00
145+00
BOTTOM OF CUT
TOP OF CUT
SEE FIGURE 3-2 FOR TYPICAL DESIGN CROSS SECTIONS
MR LEVEE
EMPIRE LOCKS
HWY 11
HWY 23
336000N
332000N
331000N
330000N
329000N
328000N
327000N
326000N
3839000E
3840000E
3841000E
3842000E
3829000E
3830000E
3831000E
3832000E
3833000E
3834000E
1000' 500' 0' 1000' 2000'

COASTAL ENGINEERING CONSULTANTS INC.
PH: (239) 643-2324
FAX: (239) 643-1143
3106 SOUTH HORSESHOE DRIVE
NAPLES, FLORIDA 34104

FIGURE 3-1: MR-B-09: BORROW AREA DESIGN PLAN

STB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751
BATON ROUGE, LA. 70821
PHONE (225) 769-3400
FAX (225) 769-3596

The seismic profiles complimented by sidescan sonar data, core data, cultural resource targets, magnetometer data, navigational constraints and USACE excavation guidelines were all utilized to refine the boundaries on MR-B-09. The use of the seismic data and surface sidescan showing the limit of sand wave bedforms were influential in creating the limits of the preliminary design plan. The MR-B-09 refined plan is linear and narrow, extending around the river bend. It is approximately 14,700 feet long, the width ranges from 360 feet to 800 feet, and the thickness is up to 24 feet. The proposed typical cross-sections for MR-B-09 are shown in Figure 3-2.

Historical water surface elevation data in the Mississippi River at Venice (USACE, 2009) shows that the water elevation in the summer and fall typically fluctuates between +3 and +4 feet NAVD88. Assuming a nominal cut depth of the dredge plant anticipated to be utilized for Project construction is 70 feet below the water surface and that dredging may occur at the higher water level, the maximum depth of cut was also evaluated at -66 feet NAVD88 to account for high water level elevations on the order of +4 feet NAVD88.

Assessment of Borrow Area MR-B-09 indicates good quality sand containing an average grain size of 0.16 mm, coarse-grained sediment. Preliminary design data studies indicate that Borrow Area MR-B-09, as reconfigured, contains between approximately 2.36 million cubic yards at -66 feet NAVD88 cut depth to 3.16 million cubic yards of sediment at -70 feet NAVD88 cut depth. The MR-B-09 isopach map is presented in Figure 3-3. The estimated volume is approximately 3.77 million cubic yards, including a 3.0 feet allowable overdredge (-73 feet NAVD88).

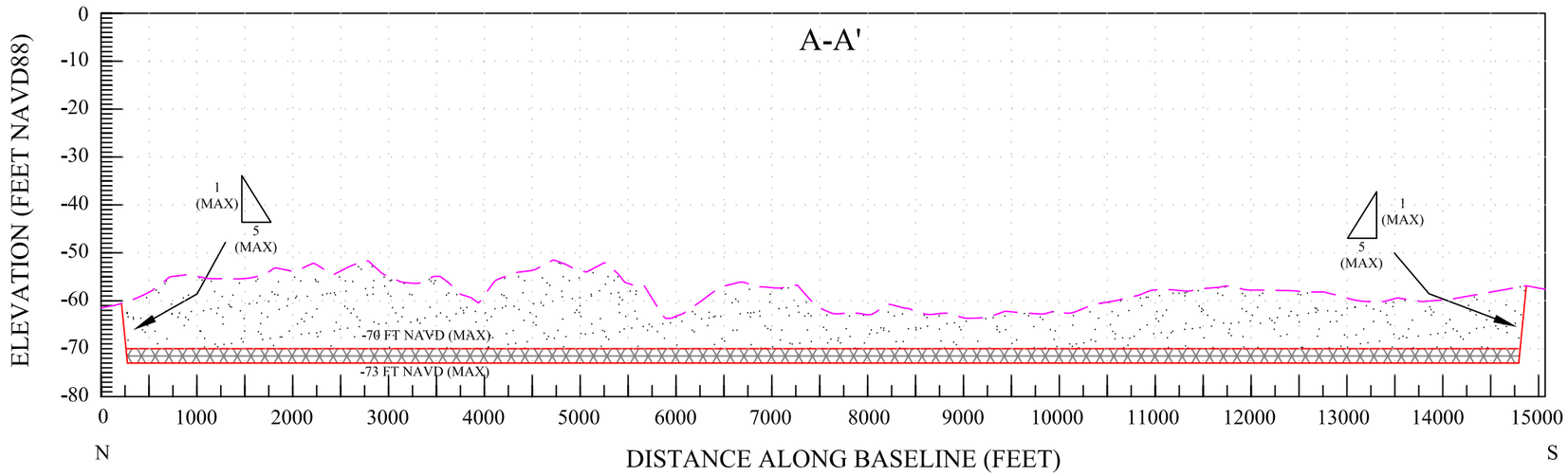
The required excavation volume for beach and dune restoration on Scofield Island as fully described in the Main Report and the Scofield Island Restoration Area Design Analysis (Appendix M) ranges from 2.24 to 2.64 million cubic yards. Thus, the proposed borrow area MR-B-09 contains sufficient volume of suitable sand for beach and dune restoration.

The geophysical investigations found no pipelines buried below the river bed that could be affected by dredge operations (CGA, 2008 and AOS, 2009a) and the CGA (2008) surveys are sufficient for cultural resources clearance.

LEGEND:

- BEACH/DUNE FILL CUT
- ALLOWABLE OVERDREDGE
- NOVEMBER 2008
- DESIGN

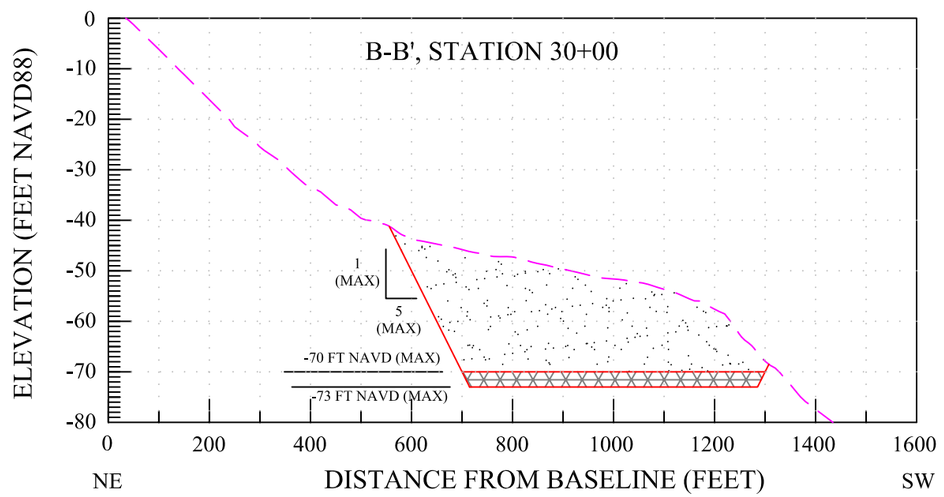
SCALE:
H: 1" = 1500'
V: 1" = 30'

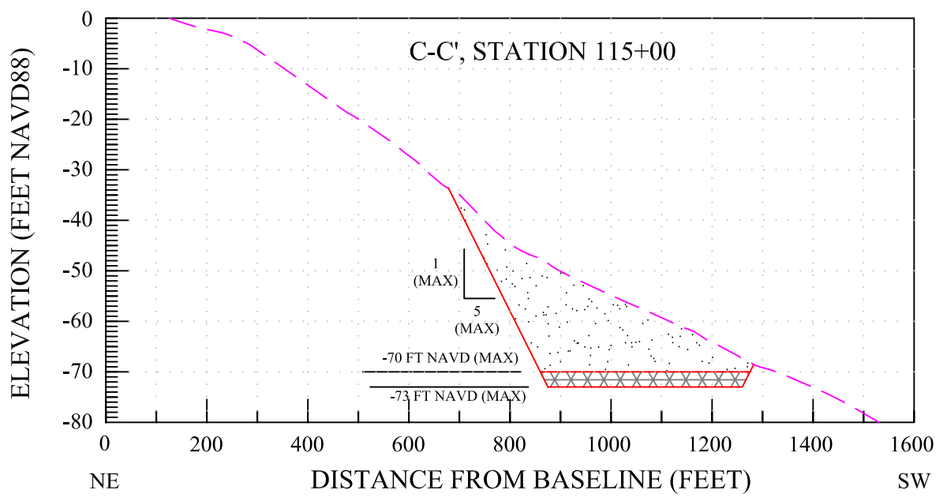


LEGEND:

- BEACH/DUNE FILL CUT
- ALLOWABLE OVERDREDGE
- NOVEMBER 2008
- DESIGN

SCALE:
H: 1" = 300'
V: 1" = 30'

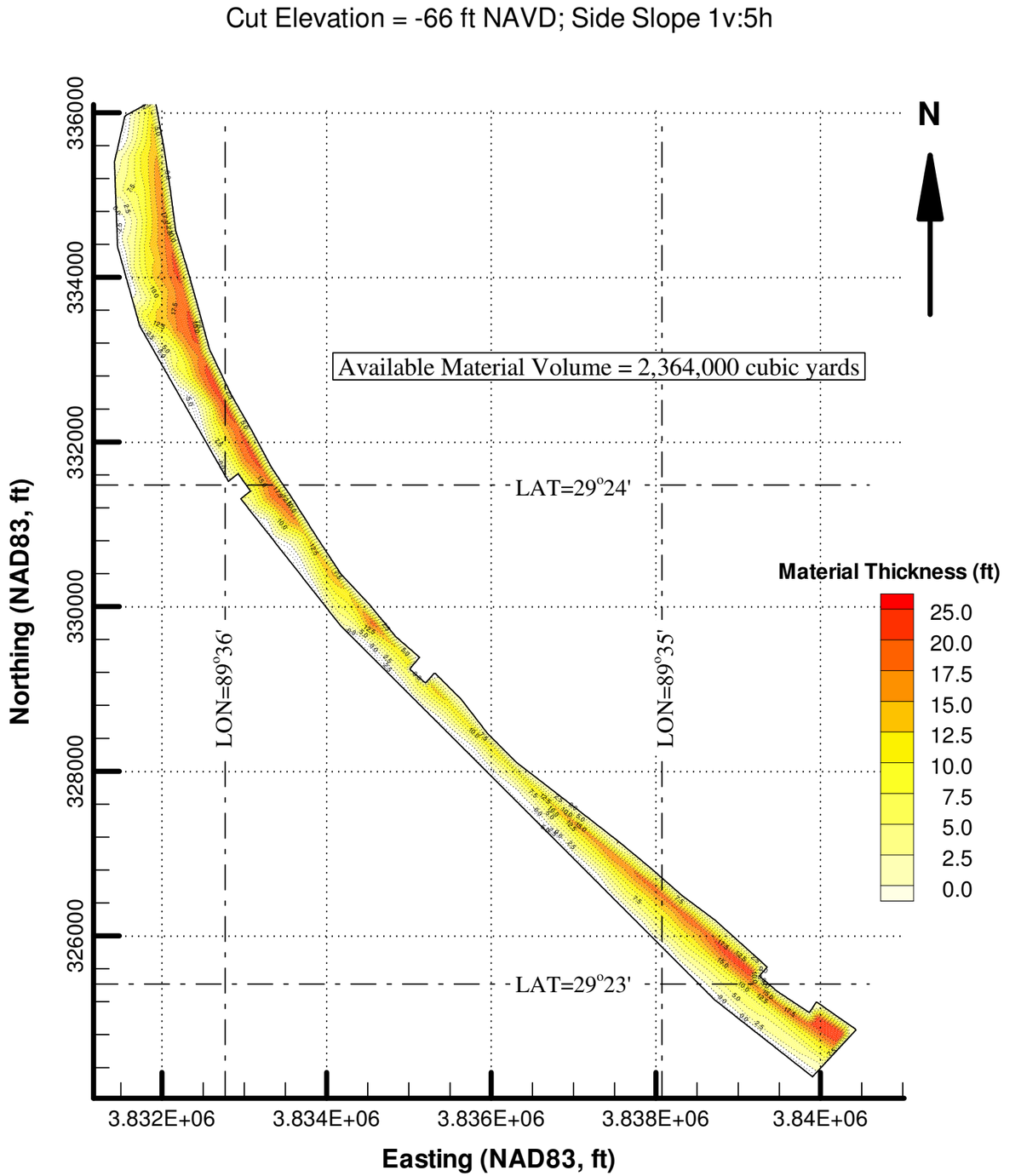


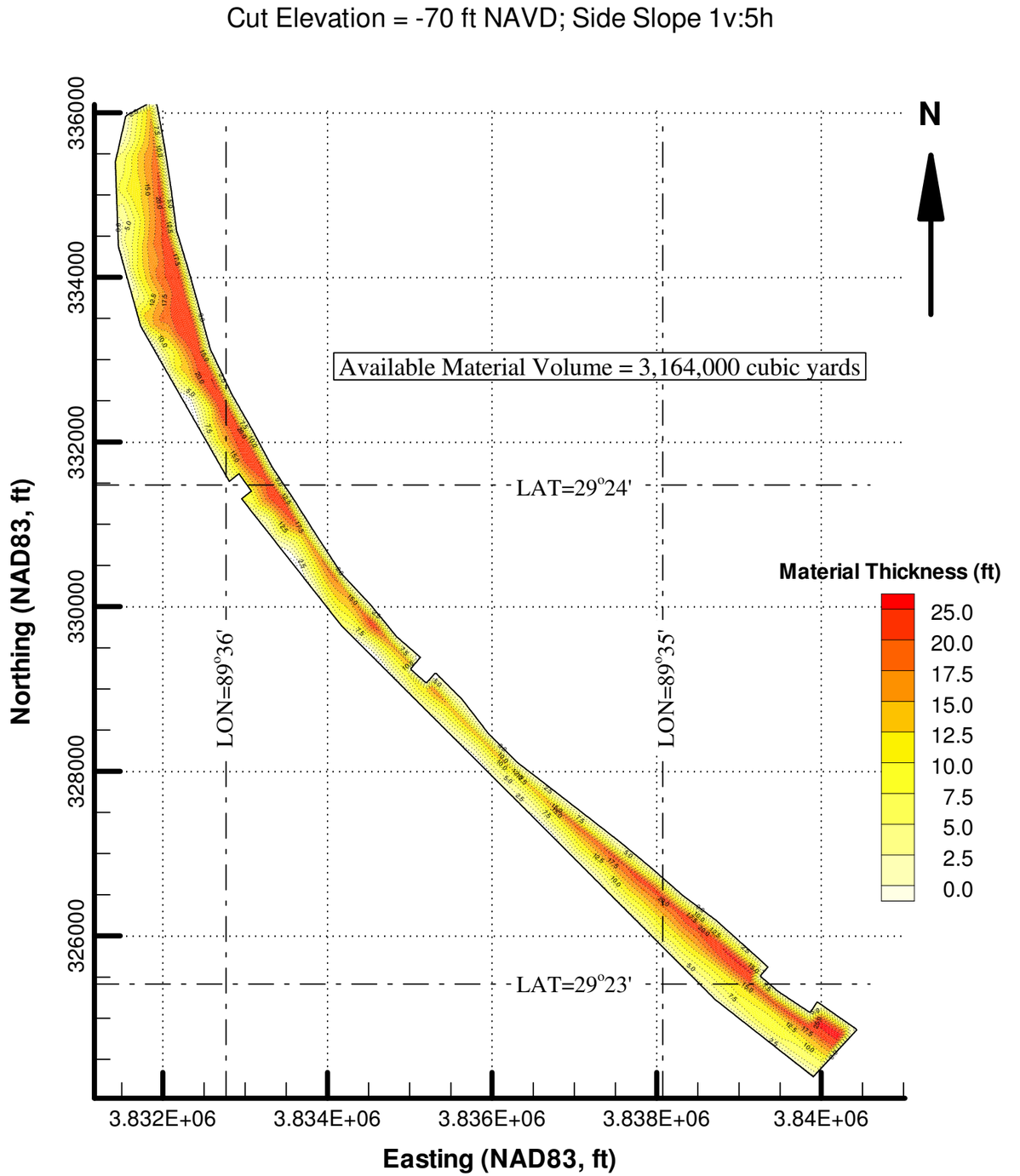


COASTAL ENGINEERING CONSULTANTS INC.
PH: (239) 643-2324
FAX: (239) 643-1143
3106 SOUTH HORSESHOE DRIVE
NAPLES, FLORIDA 34104

FIGURE 3-2: MR-B-09: TYPICAL BORROW AREA DESIGN CROSS SECTIONS

STB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751
BATON ROUGE, LA. 70821
PHONE (225) 769-3400
FAX (225) 769-3598





COASTAL ENGINEERING CONSULTANTS INC

FIGURE 3-3: MR-B-09 ISOPACH MAPS

4.0 MR-E-09 BORROW AREA ANALYSIS

4.1 MR-E-09 Geophysical Survey

AOS (2009a) conducted a detailed geophysical survey of Borrow Area MR-E-09 consisting of magnetometer, sidescan acoustic imaging, subbottom seismic, and bathymetric survey instrumentation. The track lines of the survey are shown in Figure 4-1. Over seven (7) transects, average 10,000 linear feet, were conducted parallel to the river bank at 500-foot spacing with an additional four (4) cross-channel transects.

4.1.1 MR-E-09 Magnetometer and Sidescan Results

The sidescan survey and magnetometer plan view for MR-E-09 is shown in Figure 4-2 (AOS 2009a). These data were used to define sediment bedforms, view evidence of wrecks, man-made features, or debris that might interfere with use of the area as a sand source, and to determine the presence and location of infrastructure such as pipelines.

As reported by AOS (2009a), numerous scattered magnetic anomalies were found within the survey area. None of the anomalies show a definitive alignment. The size and character of most of the anomalies is consistent with small scattered debris. Magnetic anomaly #33 aligns with sidescan target #38, which is very close to and likely related to the green channel marker buoy (anomaly #19 and #109). No large magnetic anomalies were found within the survey area. Although no large anomalies were detected, it does not rule out the possibility of larger debris being present at depth or between survey lines. Abundant scattered debris is expected throughout the entire area.

Sidescan sonar data, acquired throughout the entire MR-E-09 Borrow Area is also shown in Figure 4-2. The data primarily depict sand waves with superimposed megaripples throughout most of MR-E except near the southwestern edge. Forty-four sonar targets, both discrete and scattered, were found within the survey area.

LEGEND

- Survey Baseline
- Borrow Area Boundaries
- Shoreline Digitized From NOAA ENC Chart
- Vibracore: MRVC-05-XX (2005)
- Vibracore: MRE-08-XX (2008)
- Seismic Track Line
- Revetment
- 30 River Mile Marker

GEODETIC INFORMATION
Horizontal DATUM : WGS84
PROJECTION: NAD 83 Louisiana South State
Plane Vertical DATUM: FEET NAVD 88

3864000E 320000N 3867000E 317000N 3868000E 316000N 3869000E 315000N 3870000E 314000N 313000N 312000N

BOTTOM OF CUT
TOP OF CUT
MRVC-05-07
CHANNEL MARKER G"23" SEE NOTE 1
SEE FIGURE 4-3 FOR TYPICAL SEISMIC PROFILE
D'
D
MRVC-05-10
MISSISSIPPI RIVER LEVEE
MRE-08-09
MRE-08-05
MRE-08-10
MRE-08-13
MRE-08-08
MRE-08-07
MRE-08-11
200+00 205+00 210+00 215+00 220+00 225+00 230+00 235+00 240+00 245+00 250+00 255+00 260+00 265+00 270+00 275+00 280+00 285+00 290+00 295+00

NOTES:
1. G "23" ANCHOR LOCATED N 3863870, E 314070 AOS (2008)

800' 400' 0' 800' 1600'

FIGURE 4-1: MR-E-09: SEISMIC TRACK LINES AND VIBRACORE LOCATIONS

COASTAL ENGINEERING CONSULTANTS INC.
PH: (239) 643-2324
FAX: (239) 643-1143
3106 SOUTH HORSESHOE DRIVE
NAPLES, FLORIDA 34104

SJB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751
BATON ROUGE, LA. 70821
PHONE (225) 769-3400
FAX (225) 769-3596

LEGEND

- Survey Baseline
- Borrow Area Boundaries
- Shoreline Digitized From NOAA ENC Chart
- Magnetic Anomaly Number & Location
- Sidescan Target Number & Location
- Linear Sidescan Targets
- Vibracore: MRVC-05-XX (2005)
- Vibracore: MRE-08-XX (2008)
- Revetment
- River Mile Marker

GEODETIC INFORMATION
Horizontal DATUM : WGS84
PROJECTION: NAD 83 Louisiana South State Plane Vertical DATUM: FEET NAVD 88

3864000E 320000N 3865000E 317000N 3867000E 316000N 3868000E 315000N 3869000E 314000N 3870000E 313000N 312000N

BOTTOM OF CUT
TOP OF CUT
MRVC-05-07
CHANNEL MARKER G"23" SEE NOTE 1
MRVC-05-10
MRE-08-11
MRE-08-07
MRE-08-08
MRE-08-13
MRE-08-10
MRE-08-05
MRE-08-09
MISSISSIPPI RIVER LEVEE
200+00 205+00 210+00 215+00 220+00 225+00 230+00 235+00 240+00 245+00 250+00 255+00 260+00 265+00 270+00 275+00 280+00 285+00 290+00 295+00

NOTES:
1. G "23" ANCHOR LOCATED N 3863870, E 314070 AOS (2008)

800' 400' 0' 800' 1600'

FIGURE 4-2: MR-E-09: SEAFLOOR FEATURES, SIDESCAN, AND MAGNETOMETER TARGETS

COASTAL ENGINEERING CONSULTANTS INC.
PH: (239) 643-2324
FAX: (239) 643-1143
3106 SOUTH HORSESHOE DRIVE
NAPLES, FLORIDA 34104

STB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751
BATON ROUGE, LA. 70821
PHONE (225) 769-3400
FAX (225) 769-3596

Sixteen linear targets were also found within the survey area. A large linear target aligns with magnetic anomaly #10 but this is located beyond the northern limit of the borrow area. The most significant potential hindrance to sand mining within MR-E-09 is marked by a large linear target and magnetic anomalies #26 and #27 where there appears to be a large "Y"-shaped section of pipe or other object approximately 300 feet long. This object is located at or near the surface, but is also outside the borrow area. Other than relatively small miscellaneous debris, no other hazards were found with the sidescan in MR-E-09 (AOS 2009a).

4.1.2 MR-E-09 Subbottom Profiler Results

The surface sediments throughout the majority of the borrow area consists of sand waves with superimposed megaripples migrating downstream. The distribution of sand is generally uniform along the borrow area, with the main sand body thinning to silt and clay at the southwestern edge of the borrow area as the riverbed rapidly shoals. The sand body thickens rapidly heading away from the southwestern shoreline inside the limits of the borrow area. The sand body continues northward outside of the borrow limits to the mapped extents of this survey, in over 70 feet of water. Selected chirp profile cross-lines and long lines within MR-E-09 are denoted in Figure 4-1 and a typical section is shown in Figure 4-3.

The surface sand waves provide a good guide to define the borrow area perimeter along the shallow water side of the river. Water depth and avoidance of significant vessel traffic influence the offshore boundary of the borrow area.

4.2 MR-E-09 Geotechnical Survey

4.2.1 MR-E-09 Supplemental Core Data

A plan view map of selected boring locations that fall within the borrow area adapted from Plate 13, Boring Locations River Mile 24.2 to River Mile 17.1, from the historical Mississippi River soil report (USACE, 1971) is shown in Figure 4-4.

LEGEND:

DESIGN

SCALE:
H: 1" = 200'
V: 1" = 40'

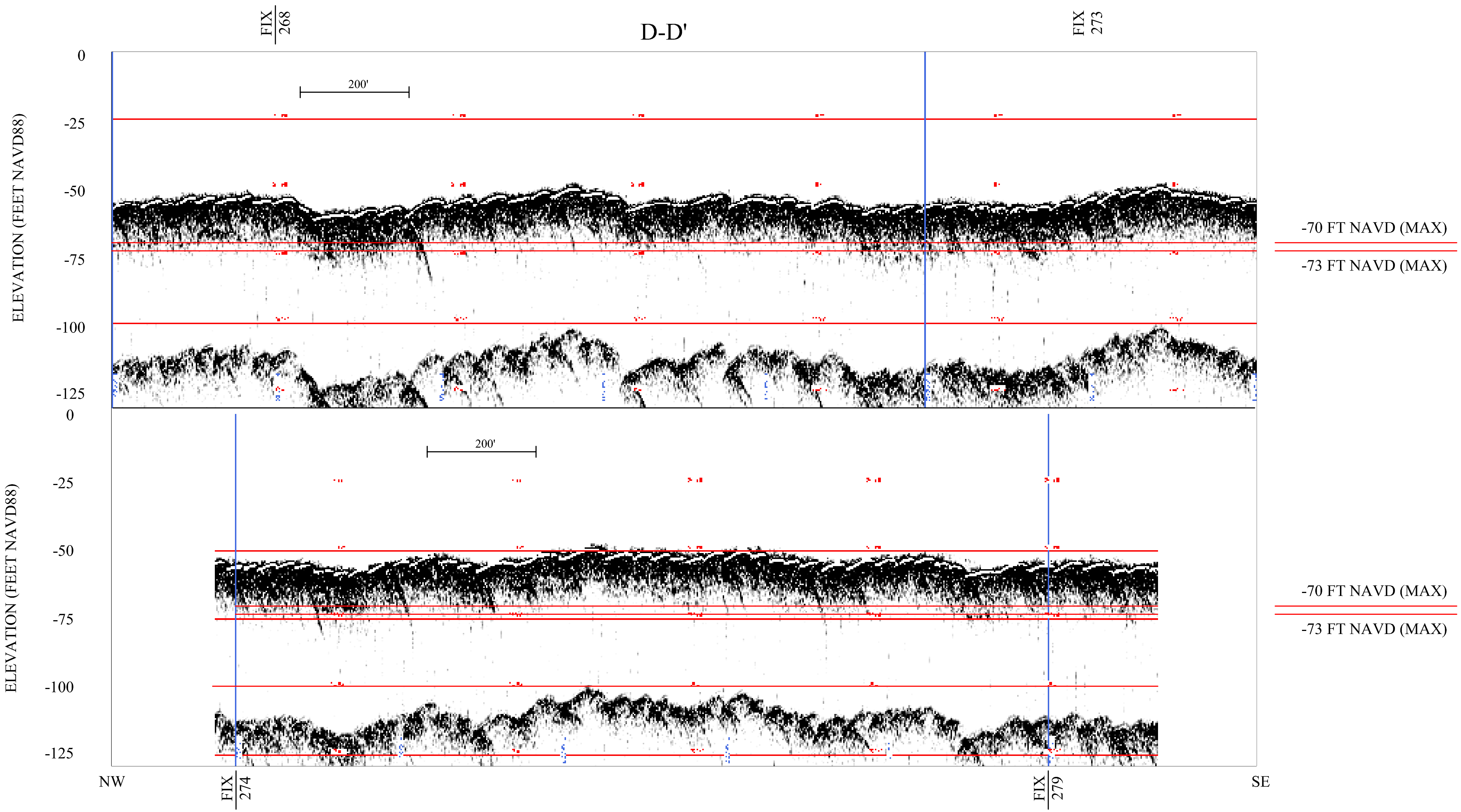


FIGURE 4-3: MR-E-09: TYPICAL SEISMIC PROFILE (AOS, 2009)

COASTAL ENGINEERING CONSULTANTS INC.
PH: (239) 643-2324
FAX: (239) 643-1143
3106 SOUTH HORSESHOE DRIVE
NAPLES, FLORIDA 34104

SJB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751
BATON ROUGE, LA. 70821
PHONE (225) 769-3400
FAX (225) 769-3596

LEGEND

- Survey Baseline (0+00)
- Borrow Area Boundaries
- Shoreline Digitized From NOAA ENC Chart
- Historic Boring Location
- Bathymetric Contour, 2008 (-20)
- Revetment
- 30 ● River Mile Marker

GEODETIC INFORMATION
Horizontal DATUM : WGS84
PROJECTION: NAD 83 Louisiana South State
Plane Vertical DATUM: FEET NAVD 88

318000N 3866000E 317000N 3867000E 316000N 3868000E 315000N 3869000E 314000N 313000N 3870000E 312000N

CHANNEL MARKER G"23" SEE NOTE 1

BOTTOM OF CUT

TOP OF CUT

HISTORIC BORING 7

HISTORIC BORING 1

HISTORIC BORING 1-S

HISTORIC BORING 2-S

HISTORIC BORING 2

HISTORIC BORING 3-S

HISTORIC BORING 3

HISTORIC BORING 4-S

HISTORIC BORING 5

HISTORIC BORING 5-S

HISTORIC BORING 8

24

23

MISSISSIPPI RIVER LEVEE

290+00 285+82 280+00 275+00 270+00 265+00 260+00 255+00 250+00 245+00 240+00 235+00 230+00 225+00 220+00 215+00 210+00 205+00 200+00 252

NOTES:
1. G "23" ANCHOR LOCATED N 3863870, E 314070 AOS (2008)

800' 400' 0' 800' 1600'

FIGURE 4-4: MR-E-09 HISTORIC BORING LOCATIONS

COASTAL ENGINEERING CONSULTANTS INC.
PH: (239) 643-2324
FAX: (239) 643-1143
3106 SOUTH HORSESHOE DRIVE
NAPLES, FLORIDA 34104

STB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751
BATON ROUGE, LA. 70821
PHONE (225) 769-3400
FAX (225) 769-3598

Core logs of the selected borings are shown in Figures 4-5 and 4-6, adapted from Plates 87 and 88 (USACE, 1971). Example logs for cores 7, 1-S, 1, 2-S, 2, and 3-S are shown in Figure 4-5. Cores 3, 4-S, 8, 5-S and 5 are shown in Figure 4-6. Cores 7, 1, 2, 3, and 8 were logged, using the Unified Soil Classification, as primarily SP, sand, poorly-graded, gravelly sands, and some SM, silty sand, sand-silt mixtures. Cores 1-S, 2-S, 3-S, 4-S, and 5-S are SP but also have a high percentage of SM silty sand. Core 5 is SP and SM sediment with some limited ML silt and CL sandy clay layers and is similar to recent cores collected along the borrow area perimeter.

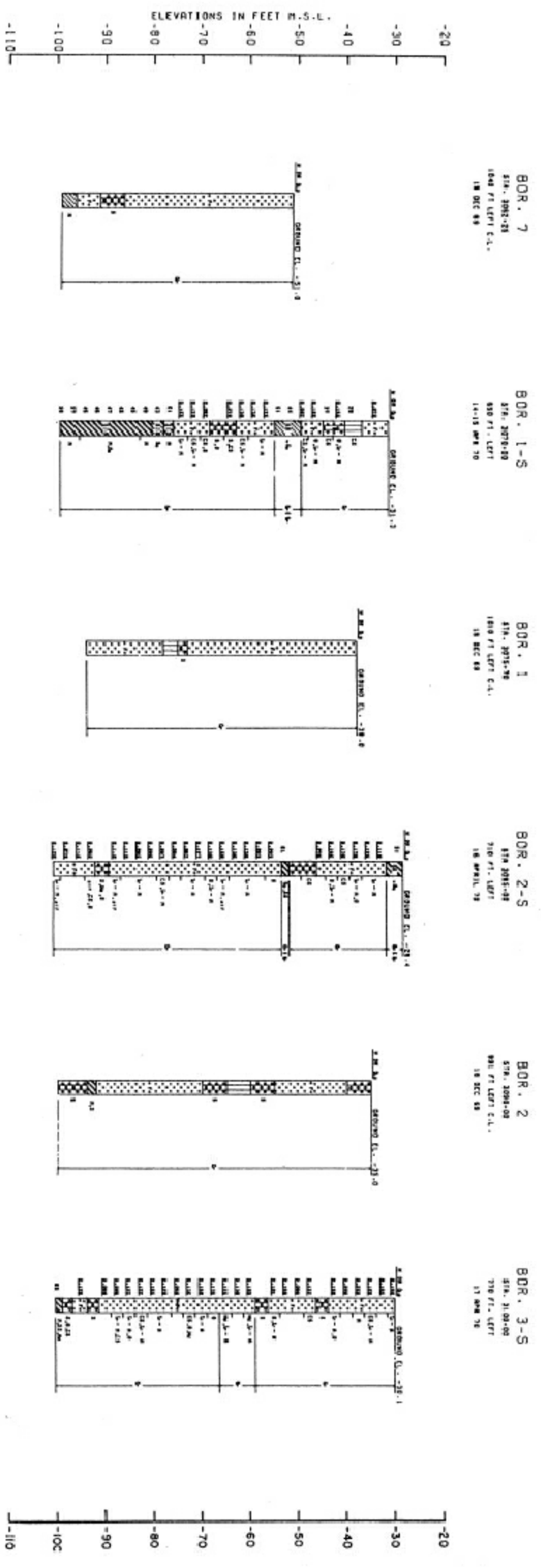
This significant core information, located in the center and along the southwestern edge of MR-E-09, is consistent with and supportive of a conclusion that Borrow Area MR-E-09 contains good quality sand at depths up to and in excess of -70 feet NAVD88.

4.2.2 MR-E-09 Vibracores

Seven vibracores by AOS (2009b) were collected along the western bank of the River in 40 feet of water to define the sediment characteristics and limits of several million cubic yards of potential borrow area sediment along the perimeter of MR-E-09 as shown in Figure 4-7. The geotechnical survey, AOS (2009b), was conducted in accordance with the USACE "Standards for Subsurface Investigations" and in accordance with the OCPR "General Guidelines: Exploration for Offshore Sand Deposits."

After collecting five 20 foot cores, the vibracore was reconfigured to collect 30 foot cores, and that configuration was used for two additional cores in MR-E-09. The core sites were selected to overlay the geophysical survey lines collected by AOS (2009a). Given the magnitude of sand potentially available along this bank, the 30 foot cores were taken in an attempt to achieve -70 feet NAVD88. Significant valuable data were obtained regarding the sediment characteristics along the western perimeter and at depth.

The recovered cores were cut into 3-foot sections and capped for ease of handling and labeled to reflect the core name, the sequence within the core, and section orientation. The cores were shipped to CTC for processing.



SJB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751
BATON ROUGE, LA. 70821
PHONE (225) 769-3400
FAX (225) 769-3596

FIGURE 4-5: MR-E-09 HISTORIC BORING LOGS

COASTAL ENGINEERING CONSULTANTS INC.
PH: (239) 643-2324
FAX: (239) 643-1143
3106 SOUTH HORSESHOE DRIVE
NAPLES, FLORIDA 34104

COASTAL ENGINEERING CONSULTANTS INC.
PH: (239) 643-2324
FAX: (239) 643-1143
3106 SOUTH HORSESHOE DRIVE
NAPLES, FLORIDA 34104

FIGURE 4-6: MR-E-09 HISTORIC BORING LOGS

BOR. 3
STA. 3185+25
1002 FT LEFT C-L.
18 DEC 69

BOR. 4-S
STA. 3115+80
518 FT. LEFT
20 APRIL 70

BOR. 8
STA. 3120+80
1060 FT LEFT C-L.
18 DEC 69

BOR. 5-S
STA. 3130+00
800 FT. LEFT
21 APRIL 70

BOR. 5
STA. 3137+25
880 FT LEFT C-L.
18 DEC 69

ELEVATIONS IN FEET M-S-L.
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110

STB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751
BATON ROUGE, LA. 70821
PHONE (225) 769-3400
FAX (225) 769-3586

LEGEND

- Survey Baseline
- Borrow Area Boundaries
- Shoreline Digitized From NOAA ENC Chart
- Vibracore: MRVC-05-XX (2005)
- Vibracore: MRE-08-XX (2008)
- Bathymetric Contour, 2008
- Revetment
- 30 River Mile Marker

GEODETIC INFORMATION
Horizontal DATUM : WGS84
PROJECTION: NAD 83 Louisiana South State Plane Vertical DATUM: FEET NAVD 88

3864000E 320000N 3865000 317000N 3867000E 316000N 3868000E 315000N 3869000E 314000N 3870000E 313000N 312000N

BOTTOM OF CUT
TOP OF CUT
MRVC-05-07
CHANNEL MARKER G"23" SEE NOTE 1
MRVC-05-10
MRE-08-09
MRE-08-05
MRE-08-10
MRE-08-13
MRE-08-08
MRE-08-11
MRE-08-07
MISSISSIPPI RIVER LEVEE
23
24
25

295+00 290+00 285+00 280+00 275+00 270+00 265+00 260+00 255+00 250+00 245+00 240+00 235+00 230+00 225+00 220+00 215+00 210+00 205+00 200+00

NOTES:
1. G "23" ANCHOR LOCATED N 3863870, E 314070 AOS (2008)

800' 400' 0' 800' 1600'

FIGURE 4-7: MR-E-09: BATHYMETRIC MAP WITH VIBRACORE LOCATIONS

COASTAL ENGINEERING CONSULTANTS INC.
PH: (239) 643-2324
FAX: (239) 643-1143
3106 SOUTH HORSESHOE DRIVE
NAPLES, FLORIDA 34104

STB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751
BATON ROUGE, LA. 70821
PHONE (225) 769-3400
FAX (225) 769-3596

Figure 4-8 presents logs of vibracores obtained along the edge of the borrow area, MRE-08-10 and MRE-08-11, comprised predominately of sand with a thin layer of silty sand or mud draped over the surface.

Typical of the historical cores, Figure 4-9 shows Vibracore MRVC-05-07, which was mostly siliciclastic sand with less than 2% fines (Finkl et al., 2005). This core, from deeper water along the central borrow area axis, is typical of the sediments in the channel where active bedforms, sand waves and megaripples, migrate.

Similar to Borrow Area MRB-09-09 and summarized by AOS (2009a), MRE-09-09 is characterized by sand bounded by prodelta and interdistributary silt and clays on the western bank. The main body of sand thins to the west of the borrow area near the riverbank. The sand body extends beyond the southeastern limits of the borrow area but drops into deeper water. The thickest observed sand sequence is on the southwestern edge of the borrow area. The main sand body is covered by sand waves with superimposed megaripples. The sediments are cross-bedded due to active bedform migration in the down-current direction.

4.3 MR-E-09 Borrow Area Sediment Analyses

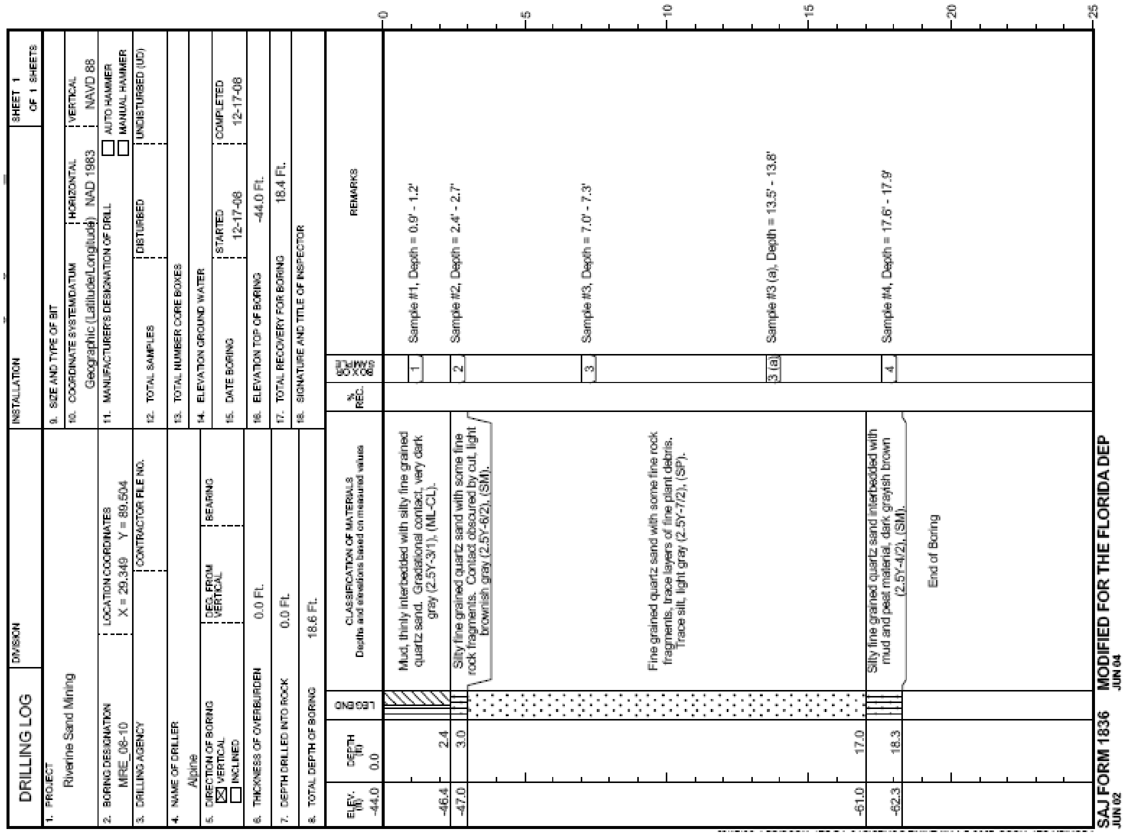
Vibracore sampling results along with historic data (USACE, 1971) confirmed both the presence of sand within the sediments but also older swamp or quiet water silt and clay rich sediment environments along the western edge of the river. The complete core boring logs and gradation analysis of sediment samples is presented in CTC (2008 and 2009).

Cores within the proposed borrow area limits were sampled and tested to determine mean grain size in millimeters (mm) and weighted percentages of coarse grained sediments. An example of the noncohesive sediment grain size from two cores is presented in Table 4-1.

Table 4-1: Composite Grain Size Summary

Borrow Area MR-E-09		
Core	**Weighted Mean GS (mm)**	**Weighted % Coarse (230) ***
MRE-08-10	0.16	99.08
MRE-08-11	0.15	98.06
Average	**0.155**	**98.57**

* = Wentworth Size Class, minimum sand grain size 0.0625 mm, #230 sieve size



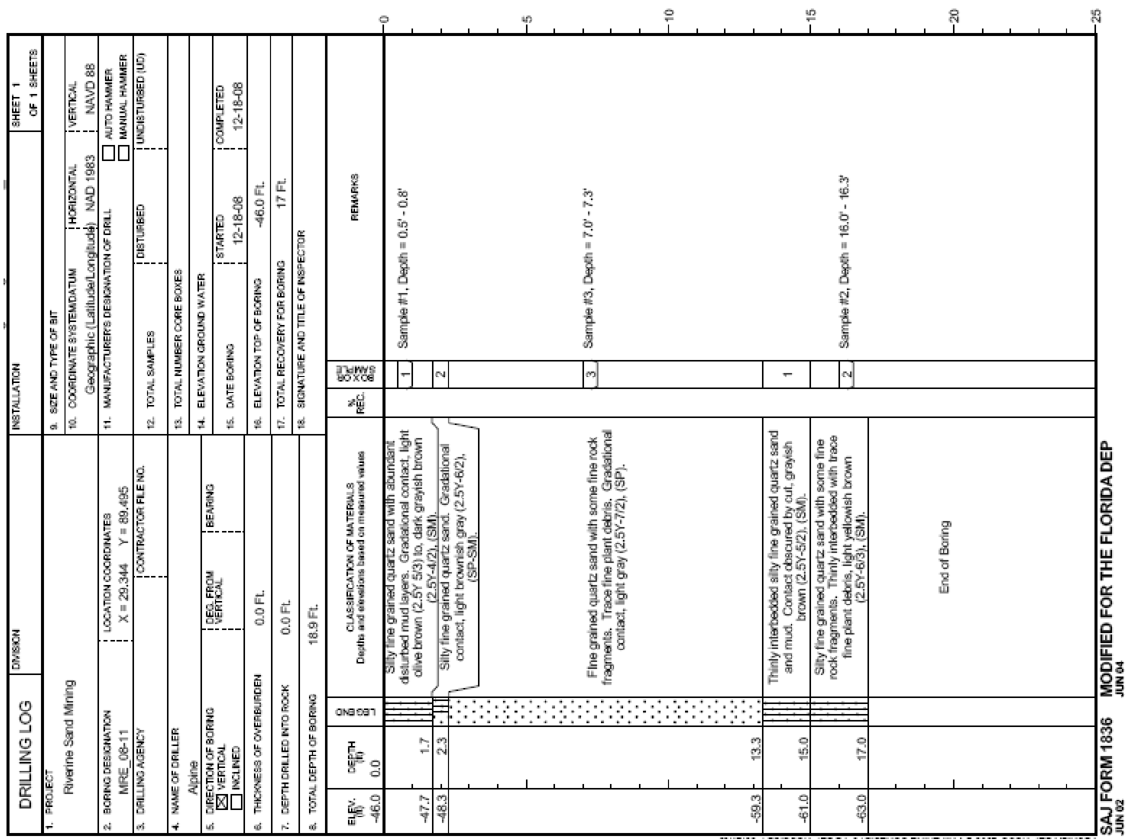


Figure 4-8: MR-E-09 – Example Core Logs MRE-08-10 and MRE-08-11

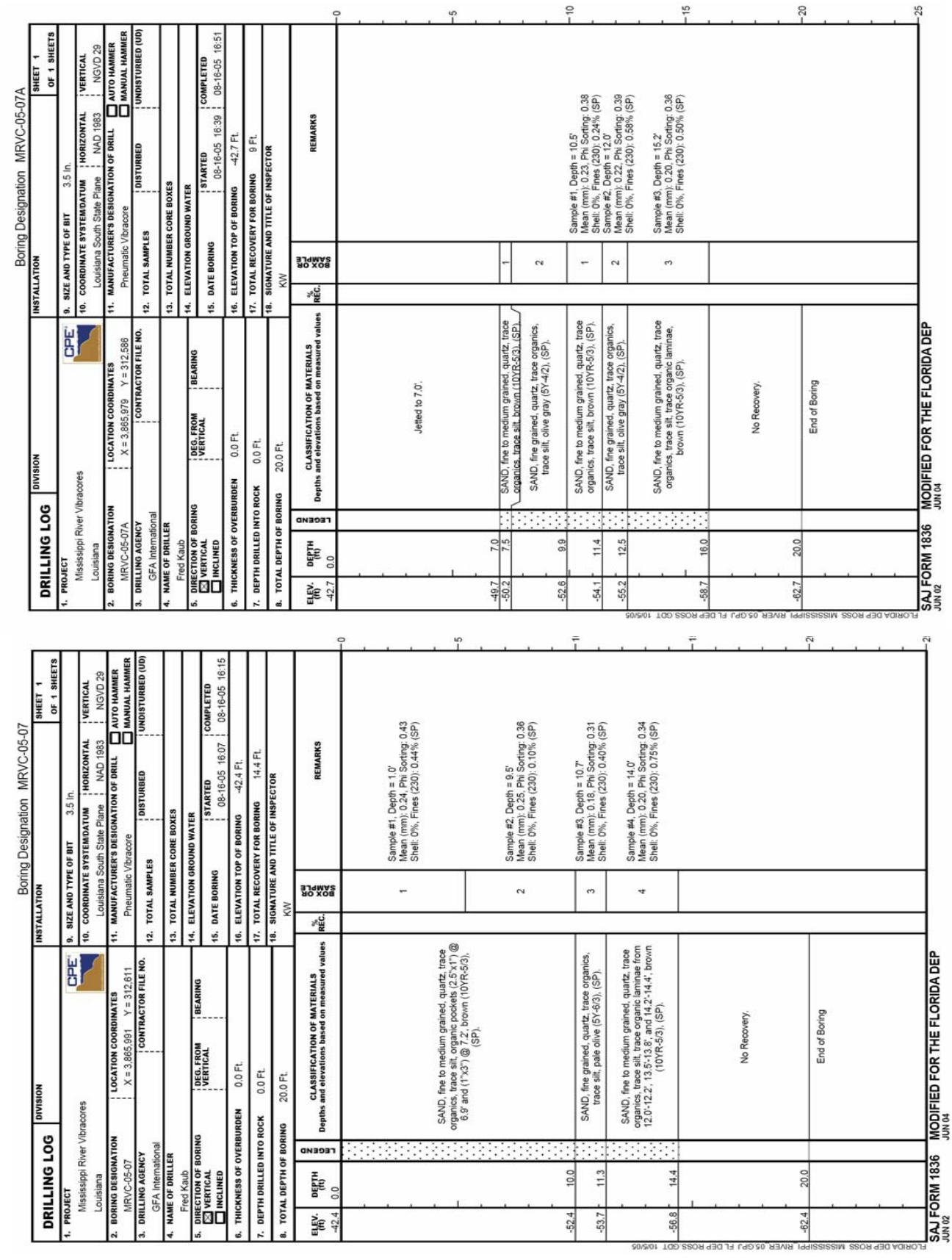


Figure 4-9: MR-E-09 – Example Core Log MRVC-05-07

Core log data for prior vibracore cores within the proposed borrow area limits (Finkl et al, 2005) also provide mean grain size in millimeters (mm). These data represent the sand size that exists at depth, from 45 feet to 60 feet, along the center of the borrow area. A summary of these data for Borrow Area MR-E-09 is presented in Table 4-2.

Table 4-2: Composite Grain Size Summary

Borrow Area MR-E-09		
Core	**Weighted Mean GS (mm)**	**Weighted % Coarse (230) ***
MRVC-05-07/07A	0.24	99.63
MRVC-05-10	0.21	98.37
Average	**0.23**	**99.00**

Source: CPE 2005
* = Wentworth Size Class, minimum sand grain size 0.0625 mm, #230 sieve size

Based on the geophysical and geotechnical data and grain size analysis, the sediments are compatible with the native beach sediments and are suitable for use in the restoring the beach and dune system on Scofield Island.

5.0 MR-E-09 BORROW AREA PLANS AND VOLUME ESTIMATES

By examining the geophysical data in concert with core logs, penetrometer data and individual grain size analyses, the borrow area shape, length, width, and depth were refined to develop the preliminary design plan. A plan view of the borrow area is shown in Figure 5-1.

The seismic profiles complimented by sidescan sonar data, core data, cultural resource targets, magnetometer data, navigational constraints and USACE excavation guidelines were all utilized to refine the boundaries on MR-E-09. The use of the seismic data and surface sidescan showing the limit of sand wave bedforms were influential in creating the limits of the preliminary design plan. The MR-E-09 refined plan is rectangular in form and is approximately 9,500 feet long by 1,100 feet wide, and the thickness is up to 25 feet. The proposed typical cross-sections for MR-E-09 are shown in Figure 5-2.

As previously stated, historical water surface elevation data shows high water elevations on the order of +4 feet NAVD88. Assuming a nominal cut depth of the dredge plant anticipated to be utilized for Project construction is 70 feet below the water surface and that dredging may occur at the higher water level, the maximum depth of cut was also evaluated at -66 feet NAVD88.

Assessment of Borrow Area MR-E-09 indicates good quality sand containing an average grain size of 0.19 mm, coarse-grained sediment. Preliminary design data studies indicate that Borrow

Area MR-B-09, as reconfigured, contains between approximately 3.86 million cubic yards at -66 feet NAVD88 cut depth to 5.02 million cubic yards of sediment at -70 feet NAVD88 cut depth. The MR-B-09 isopach map is presented in Figure 3-3. The estimated volume is approximately 5.86 million cubic yards, including a 3.0 feet allowable overdredge (-73 feet NAVD88).

As previously stated, the required excavation volume for beach and dune restoration on Scofield Island ranges from of 2.24 to 2.64 million cubic yards. Thus, the proposed borrow area MR-B-09 contains sufficient volume of suitable sand for beach and dune restoration.

The geophysical investigation found no pipelines buried below the river bed that could be affected by dredge operations (AOS, 2009a). OCPR and NOAA Fisheries shall conduct a cultural resources survey of MR-E-09 in the Final Design Phase.

LEGEND

- Survey Baseline
- Borrow Area Boundaries
- Shoreline Digitized From NOAA ENC Chart
- Vibracore: MRVC-05-XX (2005)
- Vibracore: MRE-08-XX (2008)
- Bathymetric Contour, 2008
- Revetment
- 30 River Mile Marker

GEODETIC INFORMATION
Horizontal DATUM : WGS84
PROJECTION: NAD 83 Louisiana South State
Plane Vertical DATUM: FEET NAVD 88

3864000E 320000N 3865000 3867000E 317000N 316000N 3868000E 315000N 3869000E 314000N 3870000E 313000N 312000N

BOTTOM OF CUT
TOP OF CUT
MRVC-05-07
CHANNEL MARKER G"23" SEE NOTE 1
B'
A
23
B
C'
MRVC-05-10
24
C
A'
MRE-08-11
MRE-08-07
MRE-08-08
MRE-08-13
MRE-08-10
MRE-08-05
MRE-08-09
MISSISSIPPI RIVER LEVEE
HWY 11
HWY 23
200+00 205+00 210+00 215+21 220+00 225+00 230+00 235+00 240+00 245+00 250+00 255+00 260+00 265+00 270+00 275+00 280+00 285+00 290+00 295+00

NOTES:
1. SEE FIGURE 5-2 FOR TYPICAL DESIGN CROSS SECTIONS
2. G "23" ANCHOR LOCATED N 3863870, E 314070 AOS (2008)

800' 400' 0' 800' 1600'

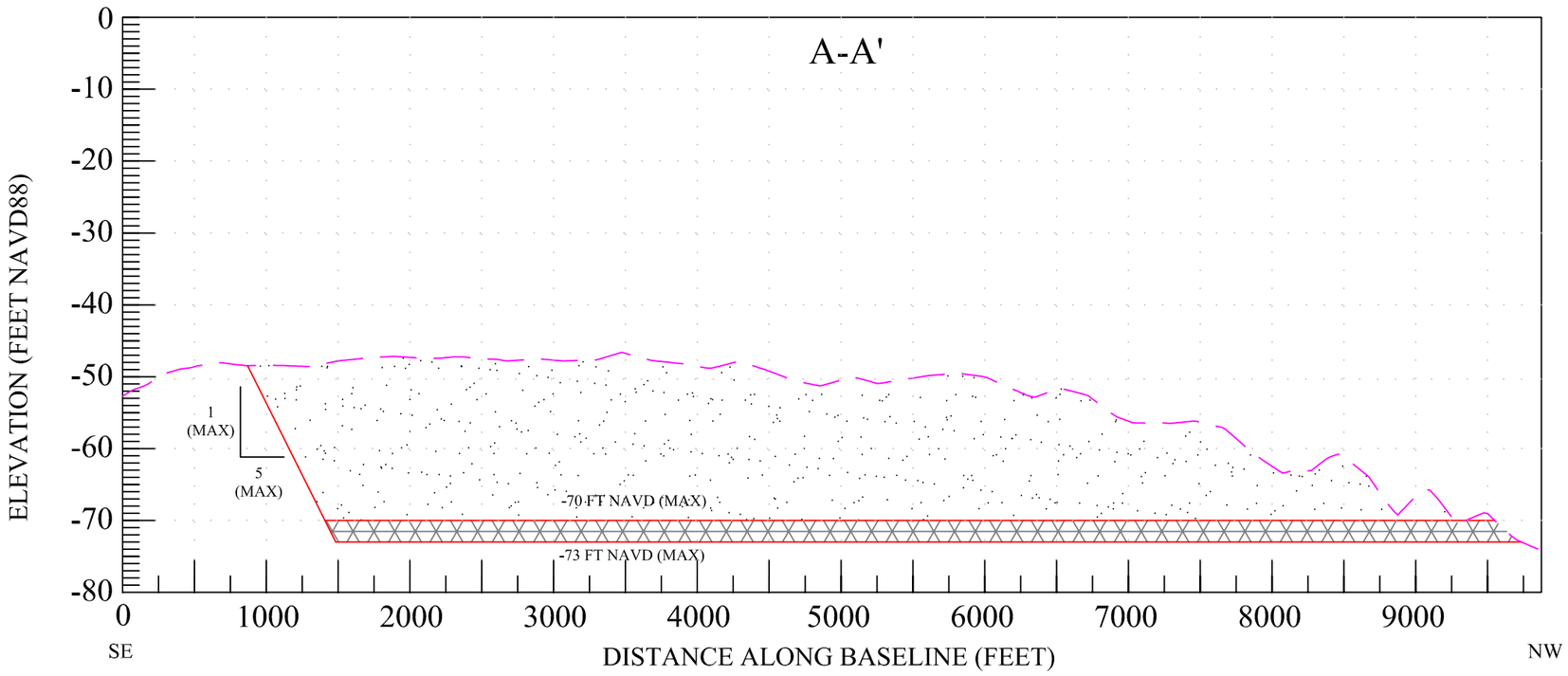
COASTAL ENGINEERING CONSULTANTS INC.
PH: (239) 643-2324
FAX: (239) 643-1143
3106 SOUTH HORSESHOE DRIVE
NAPLES, FLORIDA 34104

FIGURE 5-1: MR-E-09: BORROW AREA DESIGN PLAN

STB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751
BATON ROUGE, LA. 70821
PHONE (225) 769-5400
FAX (225) 769-3596

LEGEND:

- BEACH DUNE FILL CUT
- ALLOWABLE OVERDREDGE
- NOVEMBER 2008
- DESIGN

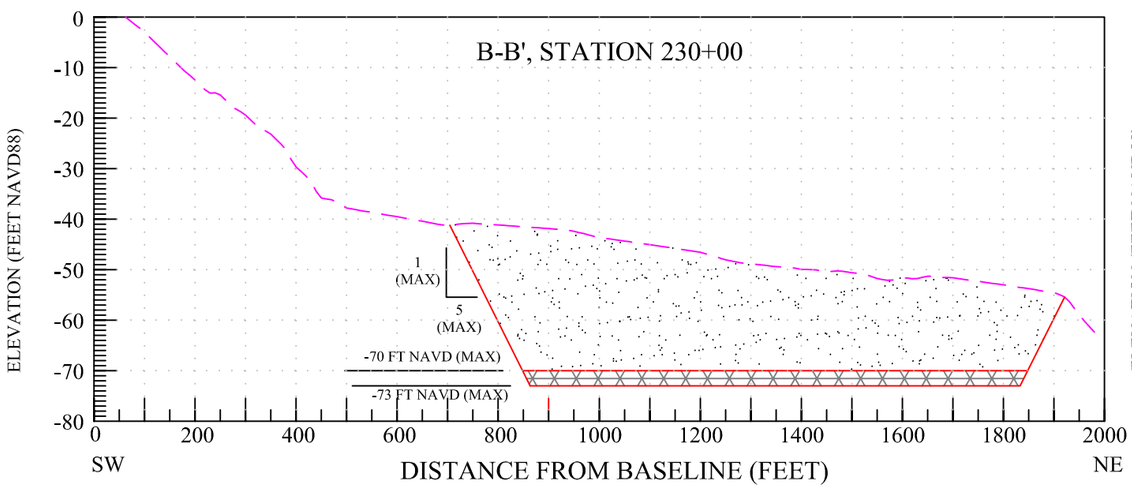


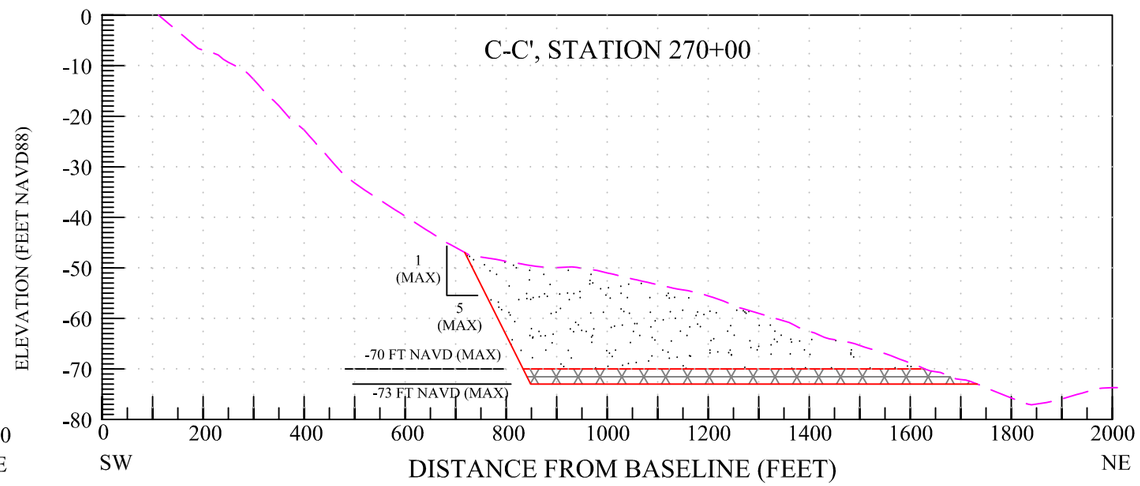
SCALE:
H: 1" = 1000'
V: 1" = 20'

LEGEND:

- BEACH DUNE FILL CUT
- ALLOWABLE OVERDREDGE
- NOVEMBER 2008
- DESIGN

SCALE:
H: 1" = 300'
V: 1" = 30'

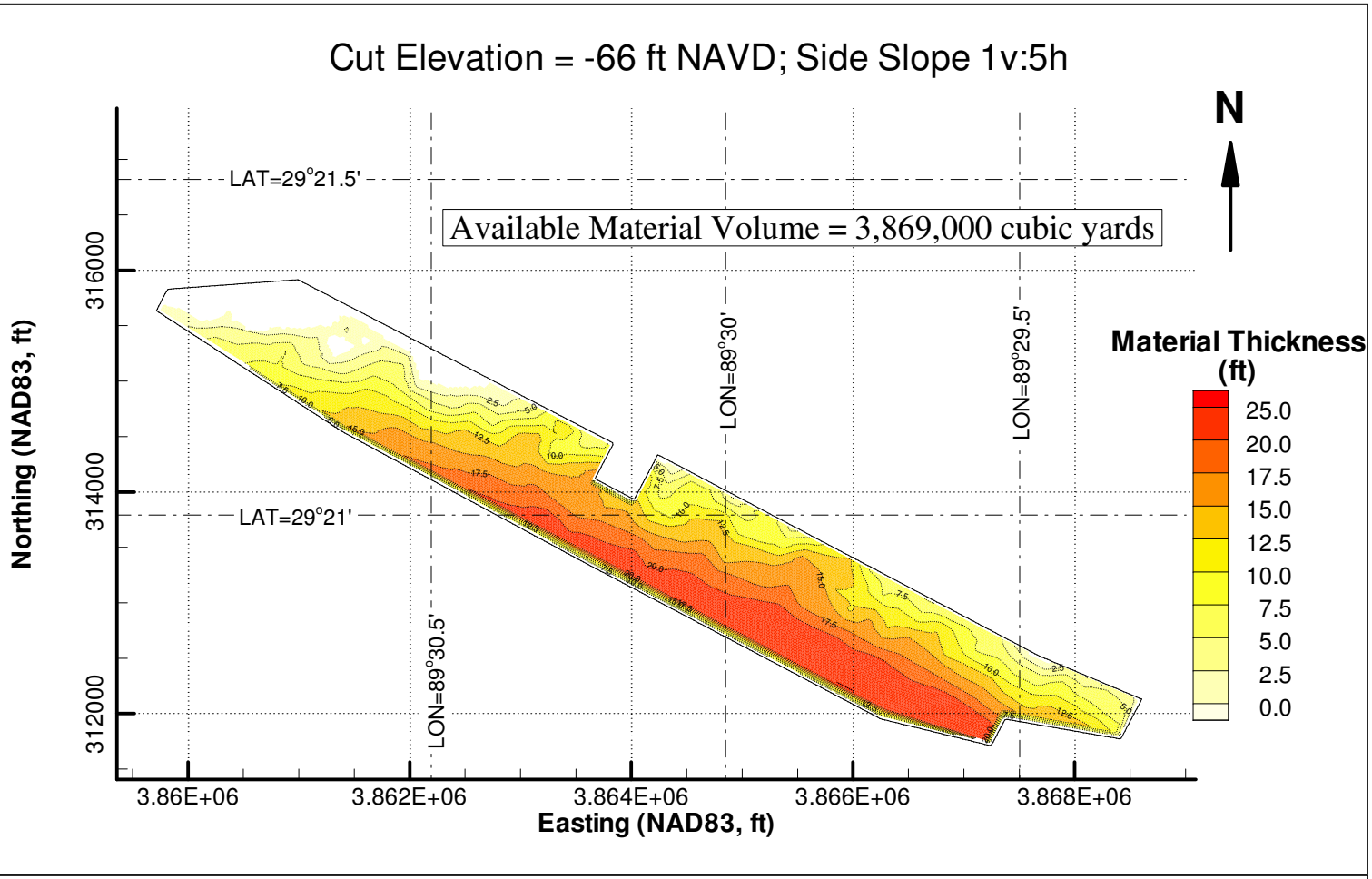


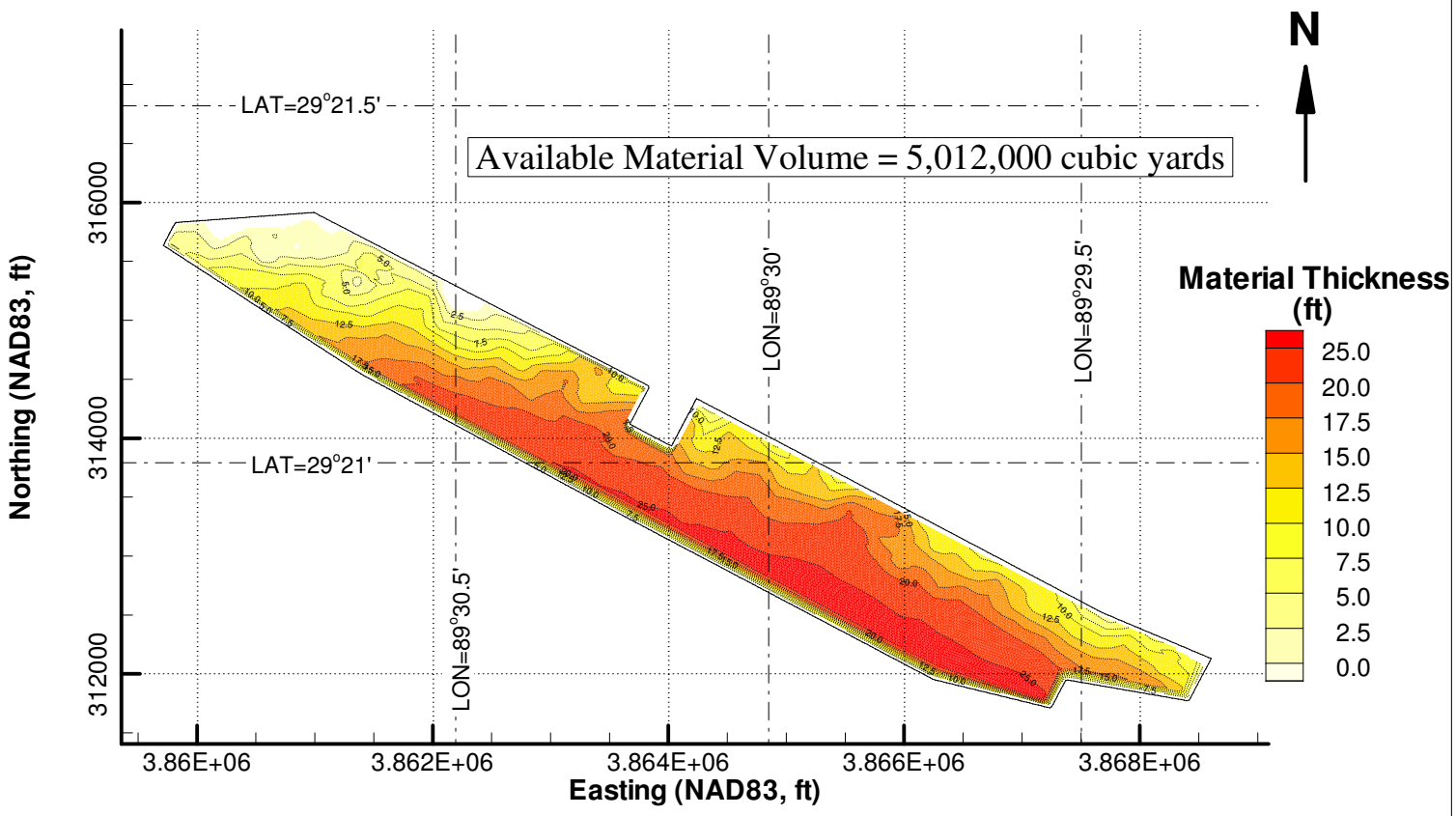


COASTAL ENGINEERING CONSULTANTS INC.
PH: (239) 643-2324
FAX: (239) 643-1143
3106 SOUTH HORSESHOE DRIVE
NAPLES, FLORIDA 34104

FIGURE 5-2: MR-E-09: TYPICAL BORROW AREA DESIGN CROSS SECTIONS

STB GROUP, LLC
QUALITY BY DESIGN
P.O. BOX 1751
BATON ROUGE, LA. 70821
PHONE (225) 769-3400
FAX (225) 769-3596





COASTAL ENGINEERING CONSULTANTS INC

FIGURE 5-3 MR-E-09 ISOPACH MAPS

6.0 SUMMARY

The seismic profiles, complimented by sidescan sonar data, core data, cultural resource targets, magnetometer data, navigation constraints and USACE excavation guidelines were utilized in concert with each other to refine the boundaries and develop the preliminary design plans for Borrow Areas MR-B-09 and MR-E-09.

6.1 Grain Size

Assessment of Borrow Areas MR-B-09 and MR-E-09 indicates good quality sand containing an average grain size of 0.16 mm and 0.19 mm, respectively.

6.2 Volumes

The preliminary design volumes and respective cut depths are summarized in Table 6-1.

Table 6-1: Borrow Area Summary

Borrow MR-B-09 Volume Calculations Average Grain Size = 0.16mm		**Borrow MR-E-09 Volume Calculations** Average Grain Size = 0.19mm	
Cut Depth	Estimated Volume	Cut Depth	Estimated Volume
-66 Feet NAVD88	2.36 myd^3	-66 Feet NAVD88	3.86 myd^3
-70 Feet NAVD88	3.16 myd^3	-70 Feet NAVD88	5.02 myd^3
-70 Feet NAVD88 Including 3 Feet Allowable Overdredge (-73 Feet NAVD88)	3.77 myd^3	-70 Feet NAVD88 Including 3 Feet Allowable Overdredge (-73 Feet NAVD88)	5.86 myd^3

6.3 Cultural Resources

The preliminary assessment of cultural resources for Borrow Areas MR-B-09 and MR-E-09 was conducted as part of the development of the Feasibility Study Phase (SJB and CEC, 2008) and followed report guidelines established by LDRCT.

It is understood the data collected in an area encompassing Borrow Area MR-B-09 (CGA, 2008) provides the magnitude and level of detail survey sufficient to fulfill the hazard, environmental, and archaeological assessment for this borrow **a**rea. A detailed cultural resources survey of Borrow Area MR-E-09 will be conducted by OCPR and NOAA Fisheries in the Final Design Phase.

6.4 Excavation Standards

Borrow Area MR-B-09 resides along the eastern bank of the river across from Empire and has no levee. Borrow Area MR-E-09 resides along the western bank of the river, which has a levee, and is constrained by the permissible limits defined below. Standards for excavation in the Mississippi River are defined in "*Limits of Permissible Excavation in River*" (USACE, 1974). The excavation proposed in borrow areas MR-B-09 and MR-E-09 meets or exceeds these minimum standards.

6.5 Tier I Contaminant Analysis and Evaluation of Exclusions

Each of these potential Borrow Areas MR-B-09 and MR-E-09 were examined in the Tier I Contaminant Analysis (SJB and C-K, 2007) and based upon the information gathered from the analysis, have been determined to meet the exemption criteria based upon 40 CFR 230.60.

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